5. Injuries to Wildlife Services: Fish Consumption Advisories

5.1 Injury Definitions

The DOI regulations include two different injury definitions related to the effects of chemical contamination on human use and consumption of fish. According to these definitions, "injury to a biological resource has resulted from the . . . release of a hazardous substance if concentration of the substance is sufficient to:"

- Exceed levels for which an appropriate State health agency has issued directives to limit or ban consumption of such organism [43 C.F.R. § 11.62 (f)(1)(iii)]
- Exceed action or tolerance levels established under section 402 of the Food, Drug and Cosmetic Act, 21 U.S.C. 342, in edible portions of organisms [43 C.F.R. § 11.62 (f)(1)(ii)].

In this chapter, injuries to fishery resources are determined using both of these regulatory tests.

5.2 Stage I Injury Assessment Approach

Table 5.1 outlines the approaches taken in this chapter to assess injury to fish according to the definitions listed above. The history and basis of fish consumption advisories (FCAs) is presented. Concentrations of PCBs in edible portions of fish are compared to FCA trigger levels used by the State of Michigan, and to federal tolerance levels.

5.3 History of KRE Fish Consumption Advisories

5.3.1 Summary of fish consumption advisories

FCAs have been issued for multiple species in the Kalamazoo River since 1979 (Figure 5.1). The reaches of the Kalamazoo River designated by the Michigan Department of Community Health (MDCH) for FCAs are from the confluence of the Kalamazoo River and the Battle Creek River to Morrow Dam, from Morrow Dam to Lake Allegan Dam (including Portage Creek), and downstream of Lake Allegan Dam. Additionally, advisories have been issued for Lake Michigan since 1977, and although these advisories are not specific to the Kalamazoo River, they apply to

Table 5.1. Approaches to evaluate injury to human use and consumption of fish

Injury definition	Stage I injury assessment approach	Chapter section
Exceed levels for which an appropriate state health agency has issued directives to limit or ban consumption of such organism [43 C.F.R. § 11.62 (f)(1)(iii)].	Present history and basis of fish consumption advisories in the Kalamazoo River, Portage Creek, and Lake Michigan.	5.3
	Compare concentrations of PCBs in edible portions of fish from the Kalamazoo River and Portage Creek to trigger levels used by Michigan.	5.4
Exceed action or tolerance levels established under section 402 of the Food, Drug and Cosmetic Act, 21 U.S.C. 342 [43 C.F.R. § 11.62 (f)(1)(ii)].	Compare concentrations of PCBs in edible portions of fish from the Kalamazoo River and Portage Creek to federal tolerance levels.	5.5

migratory fish that move up into the Kalamazoo River.[1] The advisories are communicated to the public in annual fishing guides published by MDNR (MDNR, 1977, 1978a, 1979, 1980, 1981b, 1982, 1983, 1984a, 1985, 1986, 1987c, 1988, 1989, 1990a, 1991, 1992a, 1993a, 1994a, 1995-2001).

The Kalamazoo River was not included in any FCAs before 1979 (Figure 5.1). FCAs have applied to carp (*Cyprinus carpio carpio*) and suckers (*Catostomus commersoni*) downstream of Morrow Lake since 1979. Catfish (*Ictalurus punctatus*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*M. dolomieui*), and other species not identified specifically have been under advisory downstream of Morrow Lake for most years since 1979. In addition, northern pike (*Esox lucius*) have been under advisory downstream of Lake Allegan Dam since 1985.

The Lake Michigan advisories also apply to tributaries into which migratory species enter (MDNR, 2001). Thus the advisory for Lake Michigan south of Frankfort applies to the Kalamazoo River downstream of Lake Allegan Dam (Figure 5.1). Brown trout (*Salmo trutta trutta*), chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), lake trout (*Salvelinus namaycush*), rainbow trout (*O. mykiss*), and whitefish (*Coregonus clupeaformis*) have been under the Lake Michigan advisory since the late 1970s or early 1980s. Other species such as rainbow smelt (*Osmerus mordax*), sturgeon (*Acipenser fulvescens*), walleye (*Stizostedion vitreum*), and yellow perch (*Perca flavescens*) have been under advisories since the mid- to late 1990s.

1. The Lake Michigan advisories are the result of pollutant loadings into the lake from many different sources. Based on measurements of PCB loadings from the Kalamazoo River into Lake Michigan (U.S. EPA, 2000), it is reasonable to assume that KRE PCBs have contributed to the PCB advisories in the lake. Therefore, the Lake Michigan advisories are included in this presentation and discussion of FCAs relevant to the KRE.

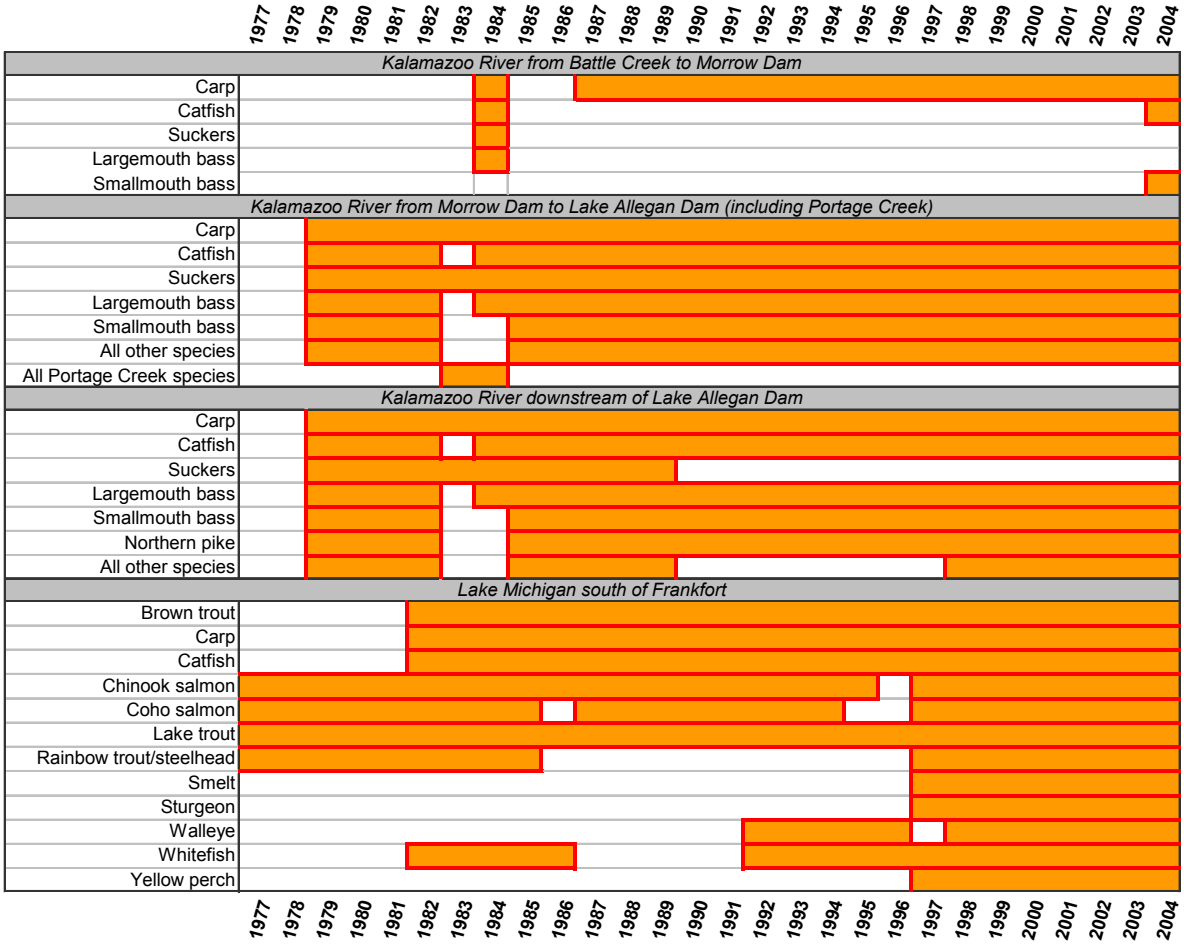

Figure 5.1. History of fish consumption advisories in the Kalamazoo River and Lake Michigan south of Frankfort. Orange bars indicate years in which there was an advisory of any kind.

Sources: MDNR, 1977, 1978a, 1979, 1980, 1981b, 1982, 1983, 1984a, 1985, 1986, 1987c, 1988, 1989, 1990a, 1991, 1992a, 1993a, 1994a, 1995-2001; U.S. EPA, 1997a; MDCH, 2002, 2003, 2004.

5.3.2 Specific descriptions of the fish consumption advisories

Advisories in the Kalamazoo River and Lake Michigan issued by the MDCH have varied over their history (Tables 5.2 and 5.3). Many of the changes were due to changes in the way the advisories were defined, such as the length of fish that are under advisory or whether a separate advisory was issued for sensitive populations. Additionally, the geographic extent of advisories varied from year to year. For example, from 1979 to 1983, there was a separate advisory for Portage Creek, but after 1983, Portage Creek was included in the advisory for the Kalamazoo River from Morrow Dam to Lake Allegan Dam.

Table 5.2. MDCH fish consumption advisories for the Kalamazoo River, 1979-2004[a]

Species	Size	1979 to 1982[b]	1983[b]	1984[c]	1985 to 1986	1987 to 1989	1990 to 1993	1994 to 1995	1996	1997	1998 to 2000	2001 to 2002	2003 to 2004
Kalamazoo River from Battle Creek to Morrow Dam													
Carp	All			1,4		4	4	4	4	4	4	0,1	0,2
Catfish	All			1,4									0,2
Suckers	All			1,4									
Largemouth bass	All			1,4									
Smallmouth bass	140-300												0,1
Kalamazoo River from Morrow Dam to Lake Allegan Dam (including Portage Creek)													
Carp	All	4	4	1,4	4	4	4	4	4	4	4	4	4
Catfish	All	4		1,4	4	4	4	4	4	4	4	4	4
Suckers	All	4	4	1,4	4	4	4	4	4	4	4	4	4
Largemouth bass	All	4		1,4	4	4	4	4	4				
	140-300									4	4	4	4
Smallmouth bass	All	4			1,4	1,4	4	4	4				
	140-300									4	4	4	4
All other species		4			1,4	1,4	1,4	1,4	1,4	1,4	1,4	1,4	1,4
All species in Portage Creek		4	4										

Table 5.2. MDCH fish consumption advisories for the Kalamazoo River, 1979-2004 (cont.)[a]

Species	Size	1979 to 1982[b]	1983[b]	1984[c]	1985 to 1986	1987 to 1989	1990 to 1993	1994 to 1995	1996	1997	1998 to 2000	2001 to 2002	2003 to 2004
Kalamazoo River downstream of Lake Allegan Dam													
Carp	All	4	4	1,4	4	4	4	4	4	4	4	4	4
Catfish	All	4		1,4	4	4	4	4	4	4	4	4	4
Suckers	All	4	4	1,4	4	4							
Largemouth bass	All	4		1,4	4	4		1,4	4				
	140-300									1,4	1,4	1,4	1,4
	> 150						1,4						
Smallmouth bass	All	4			1,4	1,4		1,4	4				
	140-300									1,4	1,4	1,4	1,4
	> 150						1,4						
Northern pike	All	4			1,4	1,4		4	4				
	≥ 220									4	4	4	4
	200-250						1,4						
	> 250						4						
All other species	All	4			1,4	1,4					0,2	0,2	0,2

4 = No consumption.
2 = Limit consumption to 1 meal (0.5 lb) per month.
1 = Limit consumption to 1 meal (0.5 lb) per week.
0 = Unlimited consumption.

a. If there is only one symbol it is the advice for the whole population. When two numbers are shown, the first is the advice for the "general population" and the second is the advice for "children and women who are pregnant, nursing, or expect to bear children." From 1979 to 1983 children are not defined by age, from 1984 to 1987 the advice is for children age 6 and under, and from 1988 to 2004 the advice is for children age 15 and under.

b. From 1979 to 1983 there is a separate advisory for "all other species" in Portage Creek; thereafter Portage Creek species are included in the Kalamazoo River from Morrow Dam to Lake Allegan Dam advisory.

c. In 1984, the advice was for the Kalamazoo River and Portage Creek, with no distinction as to the reach.

Sources: MDNR, 1977, 1978a, 1979, 1980, 1981b, 1982, 1983, 1984a, 1985, 1986, 1987c, 1988, 1989, 1990a, 1991, 1992a, 1993a, 1994a, 1995-2001; MDCH, 2002, 2003, 2004.

Table 5.3. MDCH fish consumption advisories for Lake Michigan, south of Frankfort, 1977-2004[a]

Species	Size	1977 to 1981	1982 to 1985	1986	1987 to 1991	1992 to 1994	1995	1996	1997	1998	1999 to 2000	2001 to 2004
Brown trout	All		1,4	4								
	100-220				1,4	1,4			0	0,2	0,2	0,2
	≥ 220				1,4	1,4			4	4	4	4
	> 230				4	4	4	4				
Carp	All		1,4	4	4	4	4	4	4	4	4	4
Catfish	All		1,4	1,4	4	4	4	4	4	4	4	4
Chinook salmon	All	1,4	1,4									
	100-260									0,2	0,2	0,2
	≥ 260			1,4						0,2	0,3	0,3
	210-320				1,4	1,4						
	> 320				4	4	1,4					
Coho salmon	All	1,4	1,4									
	100-300									0,2	0,2	0,2
	> 260				1,4	1,4						
	≥ 300									0,3	0,3	0,3
Lake trout	All	1,4	1,4									
	100-180								0	0,2	0,2	0,2
	180-220								1,4	1,2	1,2	1,2
	≥ 220								4	4	4	4
	200-230				1,4	1,4	1,4	1,4				
	> 230				4	4	4	4				
	≤ 250			1,4								
	> 250			4								
Rainbow trout/ steelhead	All	1,4	1,4									
	100-180									0,1	0,1	0,1
	≥ 180									0,2	0,2	0,2
Smelt	60-140									0,1	0,1	0,1
Sturgeon	≥ 300								4	4	4	4
Walleye	140-180									0,1	0,1	0,1
	180-220									0,2	0,2	0,2
	220-260					1,2	1,2	1,2		1,2	1,2	1,2
	≥ 260					1,2	1,2	1,2		1,3	1,3	1,3

Table 5.3. MDCH fish consumption advisories for Lake Michigan, south of Frankfort, 1977-2004 (cont.)[a]

Species	Size	1977 to 1981	1982 to 1985	1986	1987 to 1991	1992 to 1994	1995	1996	1997	1998	1999 to 2000	2001 to 2004
Whitefish	All		1,4	1,4								
	60-180								0	0,1	0,2	0,2
	180-220								0	0,2	0,2	0,2
	≥ 220								4	4	4	4
	> 230					4	4	4				
Yellow perch	All											
	60-80									0,1	0	0
	80-180											0,1
	80-220									0,1	0,1	

4 = No consumption.
3 = Limit consumption to 6 meals (0.5 lb) per year.
2 = Limit consumption to 1 meal (0.5 lb) per month.
1 = Limit consumption to 1 meal (0.5 lb) per week.
0 = Unlimited consumption.

a. If there is only one symbol it is the advice for the whole population. When two numbers are shown, the first is the advice for the "general population" and the second is the advice for "children and women who are pregnant, nursing, or expect to bear children." From 1977 to 1983 children are not defined by age, from 1984 to 1987 the advice is for children age 6 and under, and from 1988 to 2004 the advice is for children age 15 and under.

Sources: MDNR, 1977, 1978a, 1979, 1980, 1981b, 1982, 1983, 1984a, 1985, 1986, 1987c, 1988, 1989, 1990a, 1991, 1992a, 1993a, 1994a, 1995-2001; MDCH, 2002, 2003, 2004.

In general, when advisories did not specify different levels of protection for general populations and sensitive populations, they were applied at the most restrictive level, "no consumption." From 1984 on, when separate advice was given for general and sensitive populations, advisories were less restrictive for the general population, but in most cases remained at the "no consumption" level for sensitive members of the population.

PCBs were the only contaminants identified as being responsible for the advisories in the Kalamazoo River and Portage Creek for 1979 to 1981 and for 1989 to 2004. From 1982 to 1988 the contaminant of concern was not identified by waterbody in the advisory; instead, a preamble said that the listed "locations contained one or more chemicals at levels of public health concern." However, since PCBs were identified in advisories prior to and after the 1982 to 1988 period when advisories did not identify specific contaminants, PCBs were also most likely responsible for the advisories in these years.

PCBs have also been identified as key contaminants for the Lake Michigan FCAs. Between 1977 and 1981, PCBs were one of the key contaminants listed for chinook salmon, coho salmon, lake trout, and rainbow trout. From 1982 to 1988, the contaminant of concern was not identified by waterbody or species in the Lake Michigan advisory; instead a preamble said that "locations contained one or more chemicals at levels of public health concern." PCBs have been listed as one of the contaminants responsible for advisories in all years since 1988, and therefore are also most likely responsible for the advisories from 1982 to 1988.

5.3.3 Regulatory criteria and standards

Until 1980, Michigan issued FCAs based on the U.S. Food and Drug Administration's (FDA's) tolerance level of 5 parts per million (ppm) PCB in edible tissue (trimmed and skinned fish; Humphrey and Hesse, 1986). In 1981, Michigan adopted a trigger level of 2 ppm PCB, three years before the level was adopted by the FDA, to reduce cancer risks.

The Lake Michigan states (Michigan, Indiana, Illinois, and Wisconsin) decided in 1987 to modify the application of the 2 ppm trigger level, so that advisories were based on the percentages of fish sampled that exceeded the trigger level (Hesse, 1997). The guidance for applying these trigger levels specifies that a more severe type of advisory should be used for a greater frequency of exceedence of a trigger level.

An effort to unify protocols among Great Lakes states was made in 1993. The Great Lakes Fish Consumption Advisory Task Force recommended a health protection value of 0.05 µg PCB/kg human body weight (BW)/day (Great Lakes Sport Fish Advisory Task Force, 1993). This value was determined by consensus and based on suspected risk to human health from available data. Based on this value, five recommended advisory levels were developed depending on PCB concentrations in edible fish tissue, assumed body weights, assumed fish weights, and a factor for reduction of PCBs through cleaning of fish (Table 5.4).

Table 5.4. 1993 advisory levels recommended by the Great Lakes Fish Consumption Advisory Task Force

Fish tissue PCB concentration (ppm)	Consumption advice
0.0-0.05	Unlimited consumption
0.06-0.2	One meal/week
0.21-1.0	One meal/month
1.1-1.9	Six meals/year
> 1.9	No consumption

Source: Great Lakes Sport Fish Advisory Task Force, 1993.

The Michigan Environmental Science Board reviewed these recommendations and developed recommendations in response (Fischer et al., 1995). This panel determined that risks were highest to children and women of child-bearing age (sensitive populations). To take into account the positive benefits of eating fish, the State of Michigan decided that the recommended advisory levels were appropriate for sensitive populations, but too restrictive for the general population. Thus, as of 1998, FCAs for the general population continued to be determined based on the 2 ppm trigger level, but FCAs for sensitive populations were determined based on the guidelines recommended by the Great Lakes Fish Consumption Advisory Task Force (Table 5.4). Trigger levels for the general and sensitive populations over time are outlined in Table 5.5.

Table 5.5. FCA trigger levels used by the State of Michigan since 1977

Time period	Trigger for general population FCA (ppm)	Trigger for sensitive population FCA (ppm)
1977-1980	5	5
1981-1997	2	2
1998-present	2	0.05

Source: Hesse, 1997.

The Michigan FCA process generally takes a conservative approach toward protection of the public health. The guidance document specifies that "prudent public health professional judgment" must be part of the decision making process (Humphrey and Hesse, 1986). For example, a precautionary position may be taken before data are available to fully characterize the degree of contamination. On the other hand, to remove an advisory, "adequate data showing the absence of chemical concentrations of concern must be available . . ." (Humphrey and Hesse, 1986). Therefore, concentrations exceeding the trigger levels are to be viewed as indicative of conditions that would prompt an advisory, but an advisory may be issued without extensive concentrations over a trigger level.

5.3.4 EPA supplementary fish consumption advisories

In 1997, EPA issued a FCA based on PCBs for Michigan's Great Lakes waters that was designed to supplement the existing advisory from the MDCH (Table 5.6; U.S. EPA, 1997a). This advisory was more restrictive for certain species than those advisories developed by MDCH. For example, although MDCH advised unlimited consumption of brown trout from 10 to 22 inches in 1997, the EPA advised that the general population limit consumption to one meal per month. The advisories for lake trout and whitefish were also more restrictive, recommending restricted consumption of smaller fish when the MDCH did not. The EPA advisory also included several species that were not under advisories by the MDCH in 1997, such as coho salmon, chinook salmon, rainbow trout, yellow perch, and smelt.

Table 5.6. Comparison of MDCH and EPA fish consumption advisories for Lake Michigan south of Frankfort, 1997

Species	Size	State of Michigan advisory	EPA supplemental advisory[a]
Coho salmon	All		2
Chinook salmon	100-300		2
	> 300		3
Rainbow trout	100-180		1
	> 180		2
Brown trout	100-220	0	2
	> 220	4	4
Yellow perch	60-220		1
Smelt	60-140		1
Lake trout	100-180	0	2
	180-220	1,4	2,4
	220- > 300	4	4
Lake whitefish	60-180	0	1
	180-220	0	2
	220- > 300	4	4

4 = No consumption.
3 = Limit consumption to 6 meals (0.5 lb) per year.
2 = Limit consumption to 1 meal (0.5 lb) per month.
1 = Limit consumption to 1 meal (0.5 lb) per week.
0 = Unlimited consumption.
a. If there is only one symbol it is the advice for the whole population. When two numbers are shown, the first is the advice for the "general population" and the second is the advice for "women of childbearing age and children."
Sources: MDNR, 1997; U.S. EPA, 1997a.

Although the supplementary EPA advisory may not satisfy the injury definition in the DOI regulations at 43 C.F.R. § 11.62 (f)(1)(iii) because it was issued by EPA and not a state agency, the advisory nevertheless was issued by EPA out of public health concerns over human consumption of PCB contaminated fish (Section 5.4.2 presents a description of the basis for the supplementary advisories). Furthermore, the advisory was issued to the public and, to the extent that it affected public use or values of recreational fishing, the advisory is relevant to the discussion of recreational fishing damages (see Michigan Department of Environmental Quality et al., 2005).

5.4 Exceedences of the Michigan FCA Trigger Levels

This section compares PCB concentrations measured in KRE fish tissue with the FCA trigger levels that have been used by the MDCH [43 C.F.R. § 11.62 (f)(1)(iii)].

5.4.1 Data sources

General guidelines for analysis of fish samples for consumption advisories are to sample only edible portions (fillets). Fillet PCB concentration data are available from several data sources:

- Characterization studies conducted primarily by the MDNR (MWRC, 1972a; Wuycheck, 1978; Horvath and Greminger, 1982; MDNR, 1984b, 1987b, 1992b, 1994b; State of Michigan, 1987; Blasland, Bouck & Lee, 1992)
- Studies conducted in 1993, 1997, and 1999 by Blasland, Bouck & Lee (2001) for the RI/FS
- Long-term monitoring studies conducted in 1999 and 2000 by Camp Dresser & McKee (2001, 2002b) on behalf of MDEQ.

Characterization studies were conducted primarily by the MDNR from 1971 to 1993. The Trustees compiled the results of these studies into a database, using primary sources where available (MWRC, 1972a; Wuycheck, 1978; Horvath and Greminger, 1982; MDNR, 1984b, 1987b, 1994b; State of Michigan, 1987), and supplementing these with additional data collected by various sources available in a compilation by Blasland, Bouck & Lee (1992) and data inventoried in the STORET database system (MDNR, 1992b). Species collected include bass (unidentified species), black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), bowfin (*Amia calva*), bullhead (*Ameiurus* sp.), carp, catfish, freshwater drum (*Aplodinotus grunniens*), largemouth bass, northern pike, pumpkinseed (*Lepomis megalotis*), rock bass (*Ambloplites rupestris*), smallmouth bass, trout, walleye, white sucker (*Catostomus commersoni*), and yellow perch. Fillet samples were collected as either individual skin-on fillets or individual skin-off fillets, and were analyzed for total PCBs.

Additional individual fish fillet PCB concentration data are from samples collected for the RI/FS by Blasland, Bouck & Lee in 1993, 1997, and 1999 (Blasland, Bouck & Lee, 2001). Fish were collected by electroshocking at 12 "Aquatic Biota Sampling Areas" (ABSAs) in 1993 (Blasland, Bouck & Lee, 1994b, 1994d). Carp and smallmouth bass fillets were collected at a subset of locations in 1997 (Blasland, Bouck & Lee, 2000b). Additional fillet samples were collected in 1999 at nine of the original ABSAs, and at a new site near Saugatuck (Blasland, Bouck & Lee, 2000c). Fish collected in 1999 included black crappie, bluegill, carp, catfish, northern pike,

pumpkinseed, smallmouth bass, and walleye. Carp, catfish, and northern pike were prepared for analysis as skin-off fillets, and smallmouth bass and all other species were prepared as skin-on fillets. All samples were analyzed for PCBs as Aroclors.

Individual fish fillet PCB concentration data are also taken from samples collected as a part of long-term monitoring by Camp Dresser & McKee (2001, 2002b) on behalf of MDEQ. In 1999, carp and smallmouth bass were collected at 10 locations between Ceresco and Kalamazoo Lake by electrofishing. Additionally, one brown trout was collected from Kalamazoo Lake, two channel catfish were collected from Lake Allegan and New Richmond, and two largemouth bass were collected from New Richmond. In 2000, carp and smallmouth bass were collected from Portage Creek and four locations along the Kalamazoo River mainstem from Ceresco to Lake Allegan. Additionally, one brown trout was collected from Portage Creek, one northern pike and one rock bass were collected in the city of Kalamazoo, and one black crappie, one largemouth bass, and two walleye were collected from Lake Allegan.

All concentrations presented in this chapter are expressed on a wet weight basis. Parts per million is used to express concentrations in tissue for consistency with most of the fish consumption advisory literature, which uses ppm rather than mg/kg to describe concentrations in fish. Data used for this evaluation are as presented in source documents. No corrections or efforts to normalize the data were made to account for variability in fish length, lipid concentration, or other factors.

All fillet PCB concentration data were grouped by the Trustees to correspond with the fish consumption advisory reaches based on either descriptive sample locations or ABSAs. The ABSAs correspond to the MDCH advisory reaches as follows (Figure 5.2):

- Kalamazoo River from Battle Creek to Morrow Dam: ABSA 1 (near Battle Creek) and ABSA 2 (Morrow Lake)
- Kalamazoo River from Morrow Dam to Lake Allegan Dam: ABSA 3 (upstream of Portage Creek), ABSA 12 (Portage Creek, former Bryant Mill Pond), ABSA 4 (near Mosel Ave. in Kalamazoo), ABSA 5 (upstream of Plainwell Dam), ABSA 6 (Plainwell Dam to Otsego City Dam), ABSA 7 (upstream of Otsego Dam), ABSA 8 (upstream of Trowbridge Dam), and ABSA 9 (Lake Allegan)
- Kalamazoo River downstream of Lake Allegan Dam: ABSA 10 (Swan Creek Marsh), ABSA 11 (near New Richmond), and ABSA 13 (near Saugatuck).

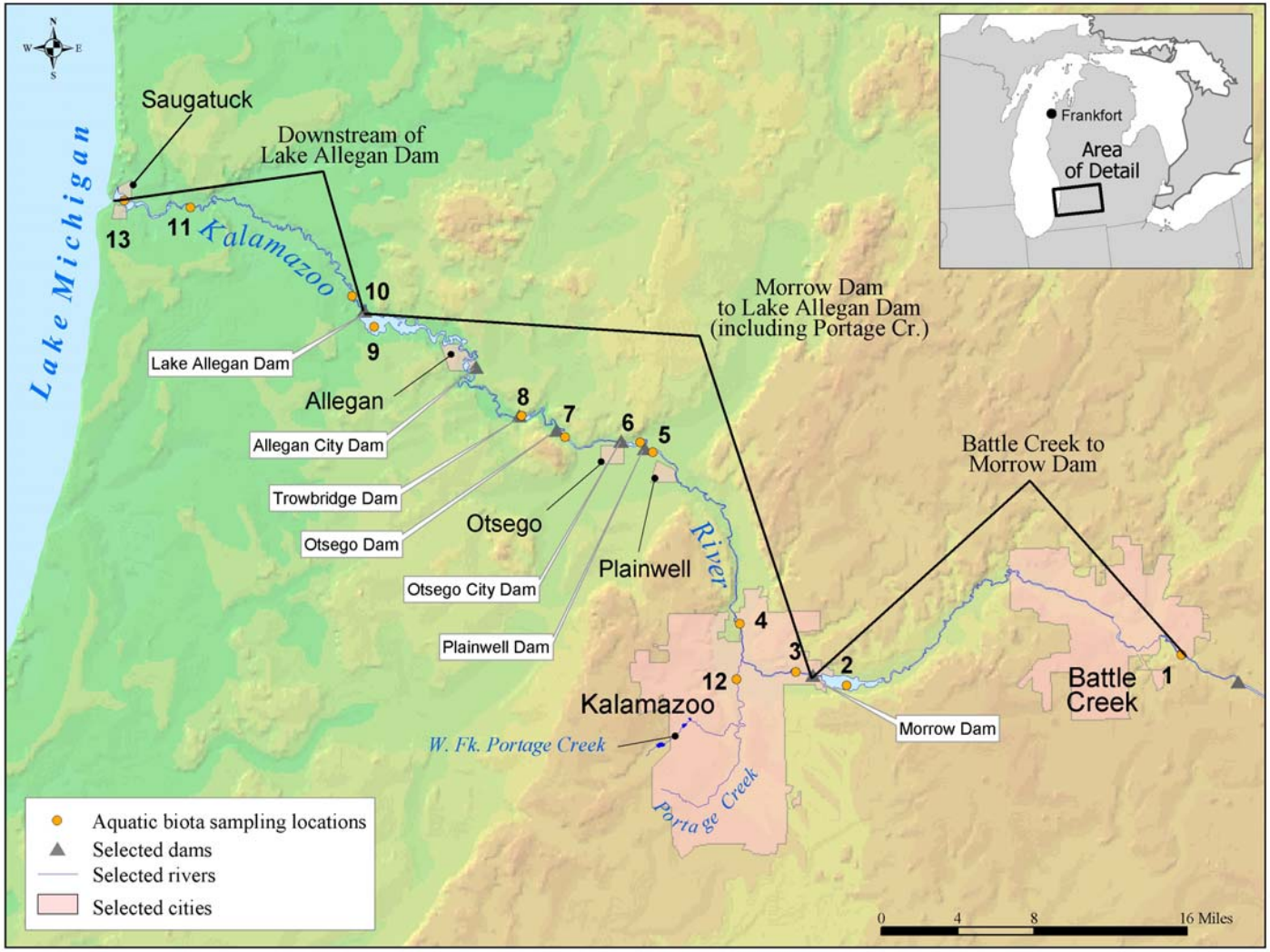

Figure 5.2. Reaches of the Kalamazoo River as designated by MDCH for fish consumption advisories, and distribution of RI/FS ABSAs within these reaches.

5.4.2 Results

PCB concentrations in fillets were compared to appropriate trigger levels for the Michigan advisory process for a given time period. A trigger level of 5 ppm was applied before 1981, a trigger level of 2 ppm was applied from 1981 on, and an additional trigger level of 0.05 for the minimum sensitive population advisory was applied from 1998 on (see Table 5.5). The purpose of these comparisons was to examine the consistency of Michigan's advisories with reported fish tissue data. Although specific advisories were not issued in the Kalamazoo River and Portage Creek until 1979, the 5 ppm trigger level was applied to samples collected before this year because data from this time period would have been relevant to developing the advisory.

In the Kalamazoo River upstream of Morrow Dam, only carp are currently under a consumption advisory. PCB concentrations in carp fillets have been measured at concentrations greater than the trigger levels since 1971 (Figure 5.3). Many samples exceeded the 2 ppm trigger level in the early 1980s, but no samples collected since 1987 have exceeded 2 ppm. More recent samples exceed the trigger level for sensitive populations. Although PCB concentrations in other species in this reach have also exceeded trigger levels on occasion, they generally have fallen below the 5 ppm and 2 ppm trigger levels over time (Figure 5.4).

PCB concentrations in edible portions of fish collected from Morrow Dam to Lake Allegan Dam were much higher than those upstream (Figures 5.5-5.10) and correspond with the more extensive advisories in this reach (see Table 5.2). Carp fillets had concentrations at least an order of magnitude higher than the trigger levels, and samples exceeded the trigger levels in all years when they were collected (Figure 5.5). Catfish samples were only collected in this reach in 1981 and 1999 (Figure 5.6). The one sample collected in 1981 fell slightly below the 2 ppm trigger level, however many of the samples collected in 1999 were higher than 2 ppm, and all of them exceeded the 0.05 ppm trigger level for sensitive populations. Largemouth bass (Figure 5.7), smallmouth bass (Figure 5.8), and white sucker (Figure 5.9) fillet samples also frequently exceeded the trigger levels. All other species are under a general advisory from Morrow Dam to Lake Allegan Dam. While the majority of samples from bass (unidentified species), black crappie, bluegill, bullhead, northern pike, pumpkinseed, rock bass, trout, and walleye had concentrations below trigger levels, many fillets did exceed the general population trigger level of 2 ppm and all but one bluegill fillet had concentrations higher than the 0.05 ppm trigger level for a sensitive population advisory (Figure 5.10).

Concentrations of PCBs in fillets of fish collected downstream of Lake Allegan Dam also exceeded advisory trigger levels (Figures 5.11-5.20). Many concentrations in carp fillets were several times higher than all of the trigger levels (Figure 5.11), and were similar to concentrations between Morrow Dam and Lake Allegan Dam (see Figure 5.5). Although samples were collected less regularly, concentrations in catfish (Figure 5.12), largemouth bass (Figure 5.13), northern pike (Figure 5.14), smallmouth bass (Figure 5.15), trout (Figure 5.16),

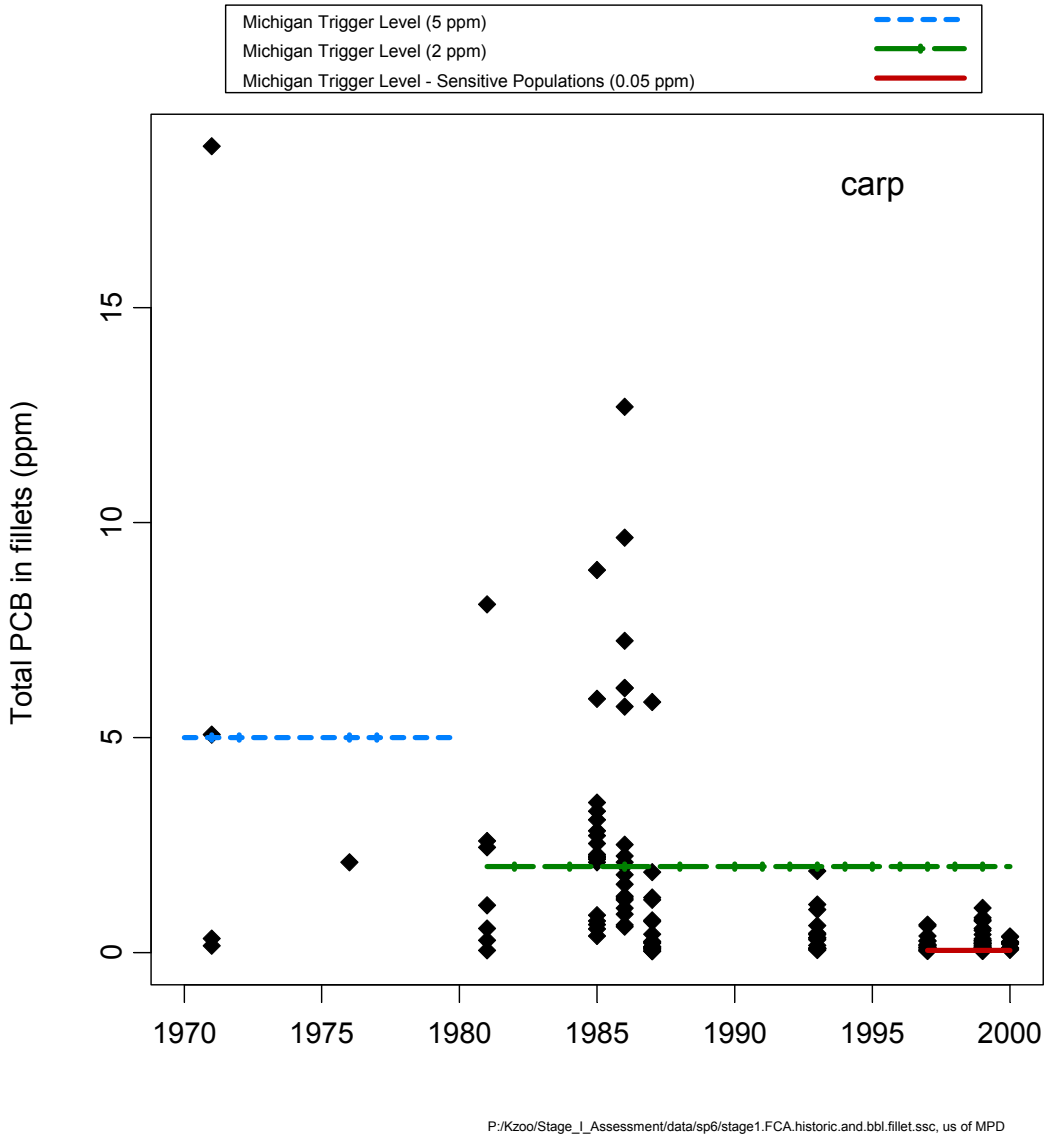

Figure 5.3. Total PCBs in fillets of carp collected upstream of Morrow Dam, 1971-2000.

Source: See Section 5.4.1.

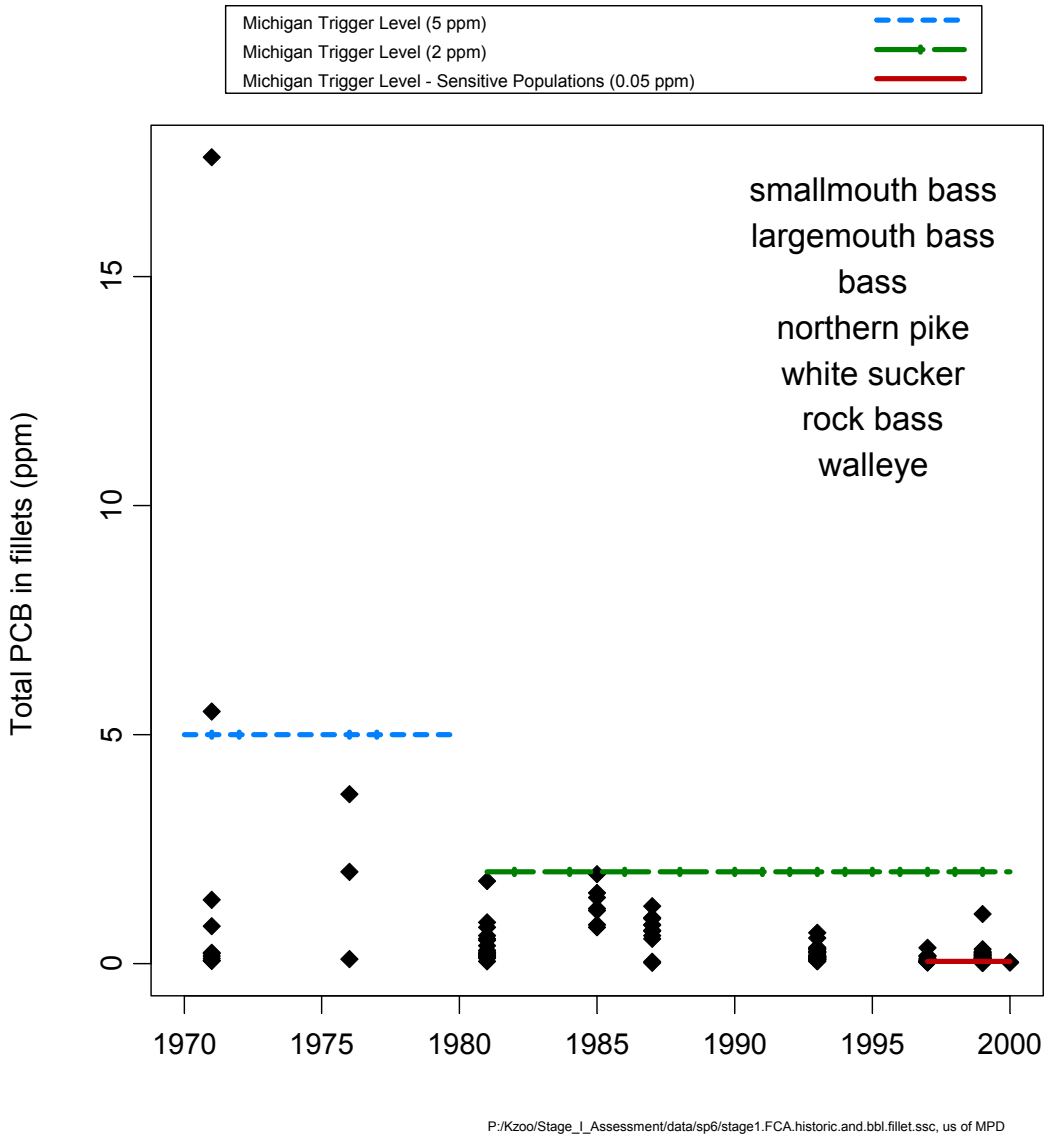

Figure 5.4. Total PCBs in fillets of species not currently under an advisory collected upstream of Morrow Dam, 1971-2000.

Source: See Section 5.4.1.

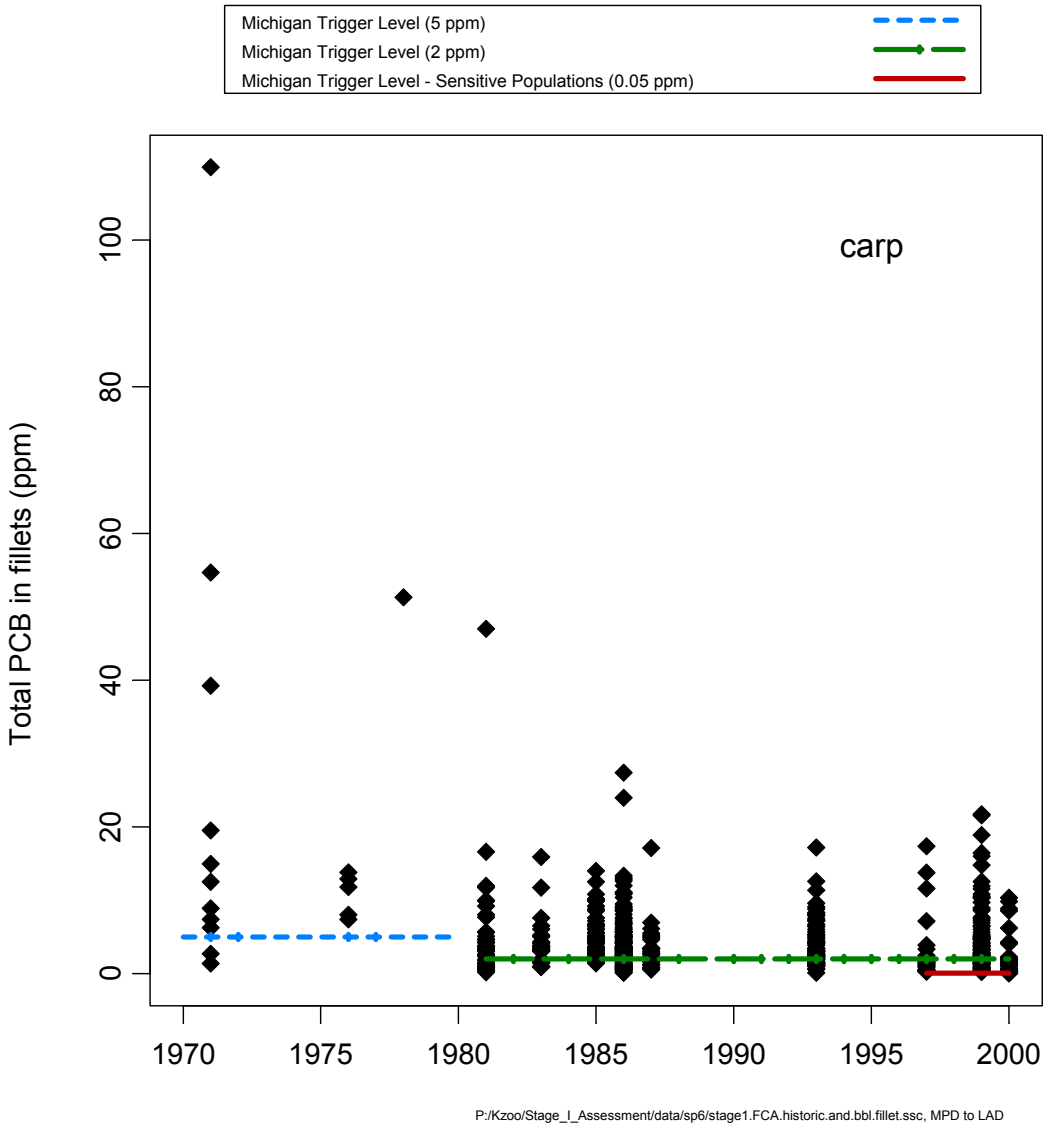

Figure 5.5. Total PCBs in fillets of carp collected between Morrow Dam and Lake Allegan Dam, 1971-2000.

Source: See Section 5.4.1.

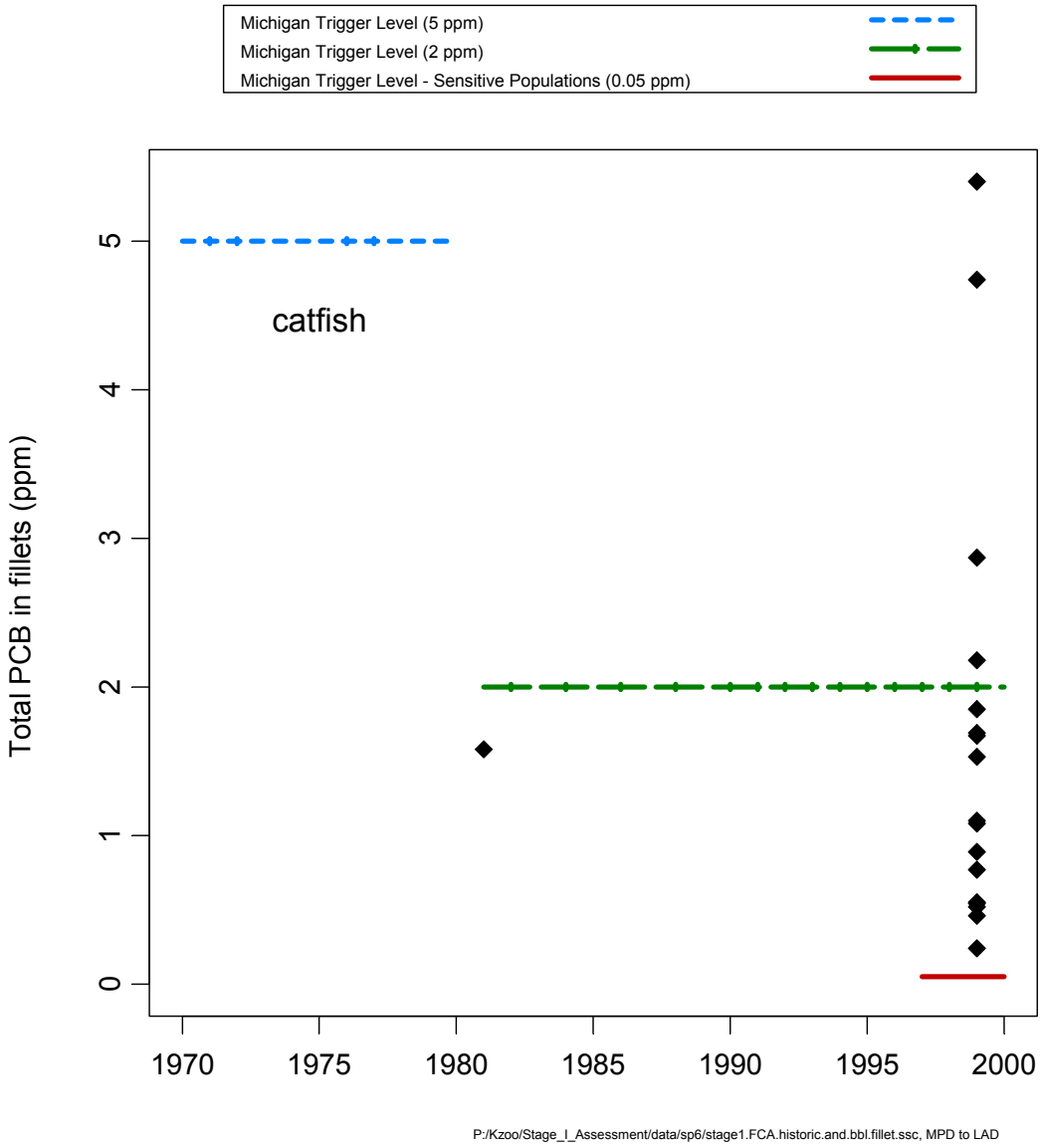

Figure 5.6. Total PCBs in fillets of catfish collected between Morrow Dam and Lake Allegan Dam, 1971-2000.

Source: See Section 5.4.1.

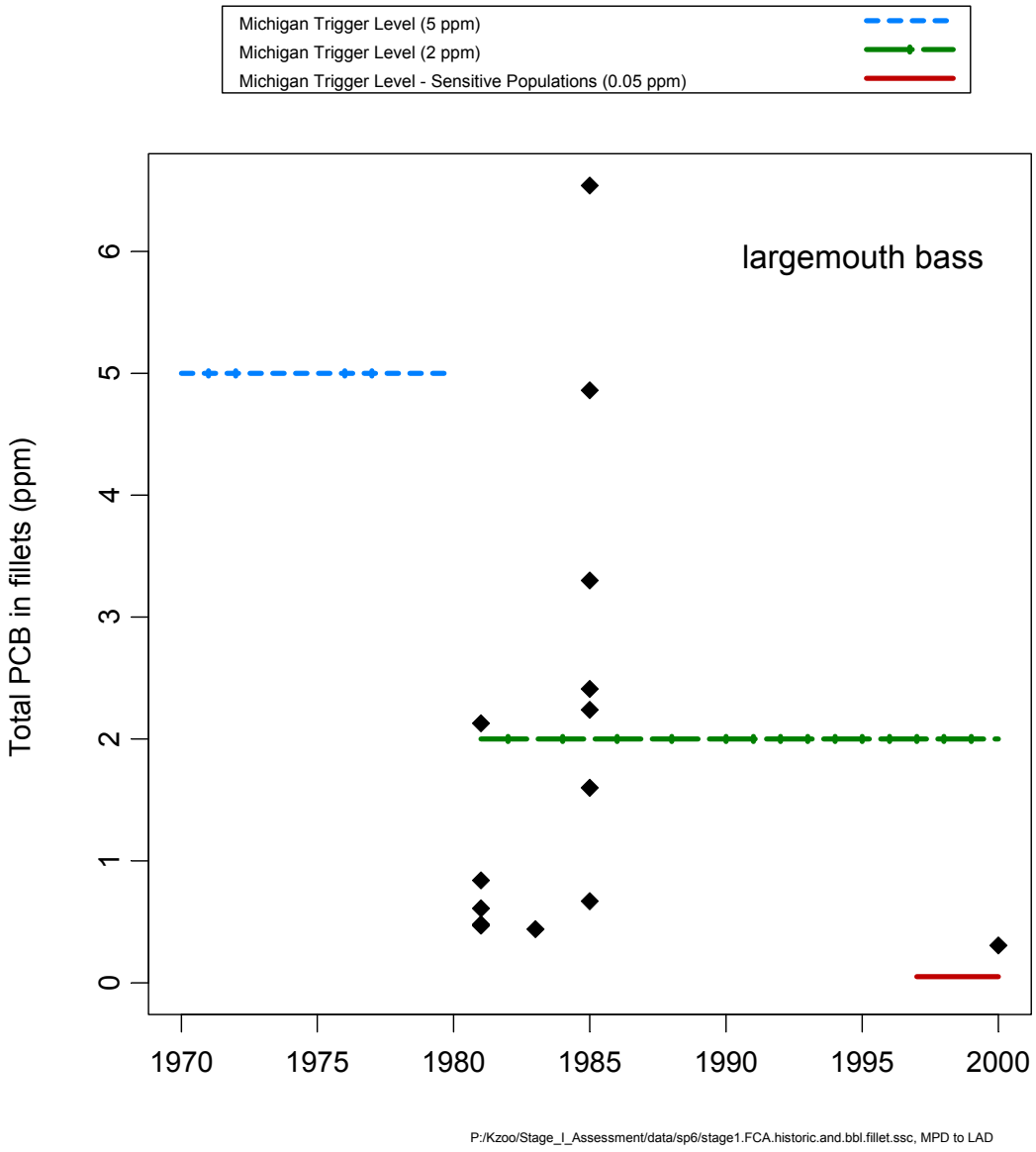

Figure 5.7. Total PCBs in fillets of largemouth bass collected between Morrow Dam and Lake Allegan Dam, 1971-2000.

Source: See Section 5.4.1.

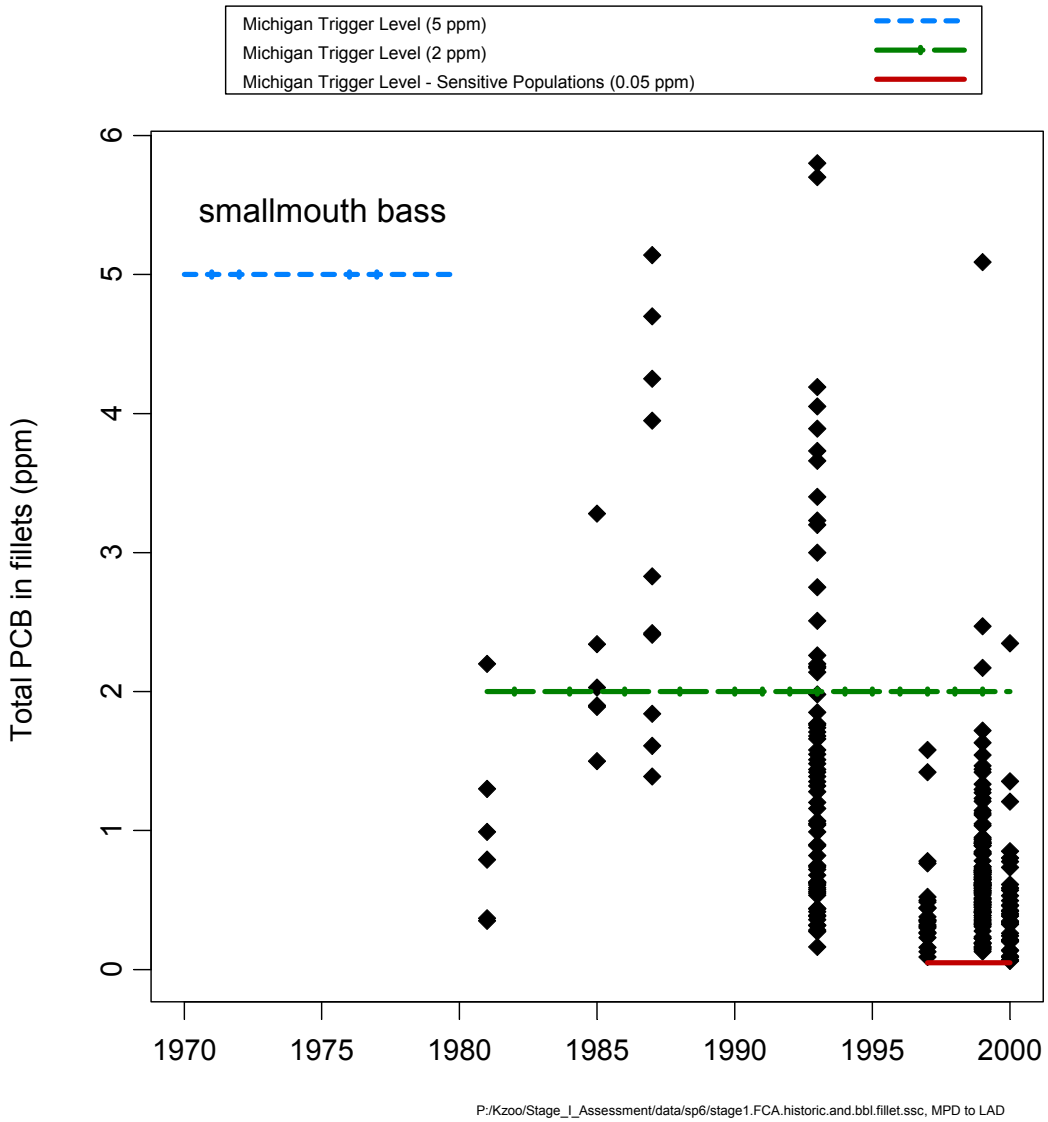

Figure 5.8. Total PCBs in fillets of smallmouth bass collected between Morrow Dam and Lake Allegan Dam, 1971-2000.

Source: See Section 5.4.1.

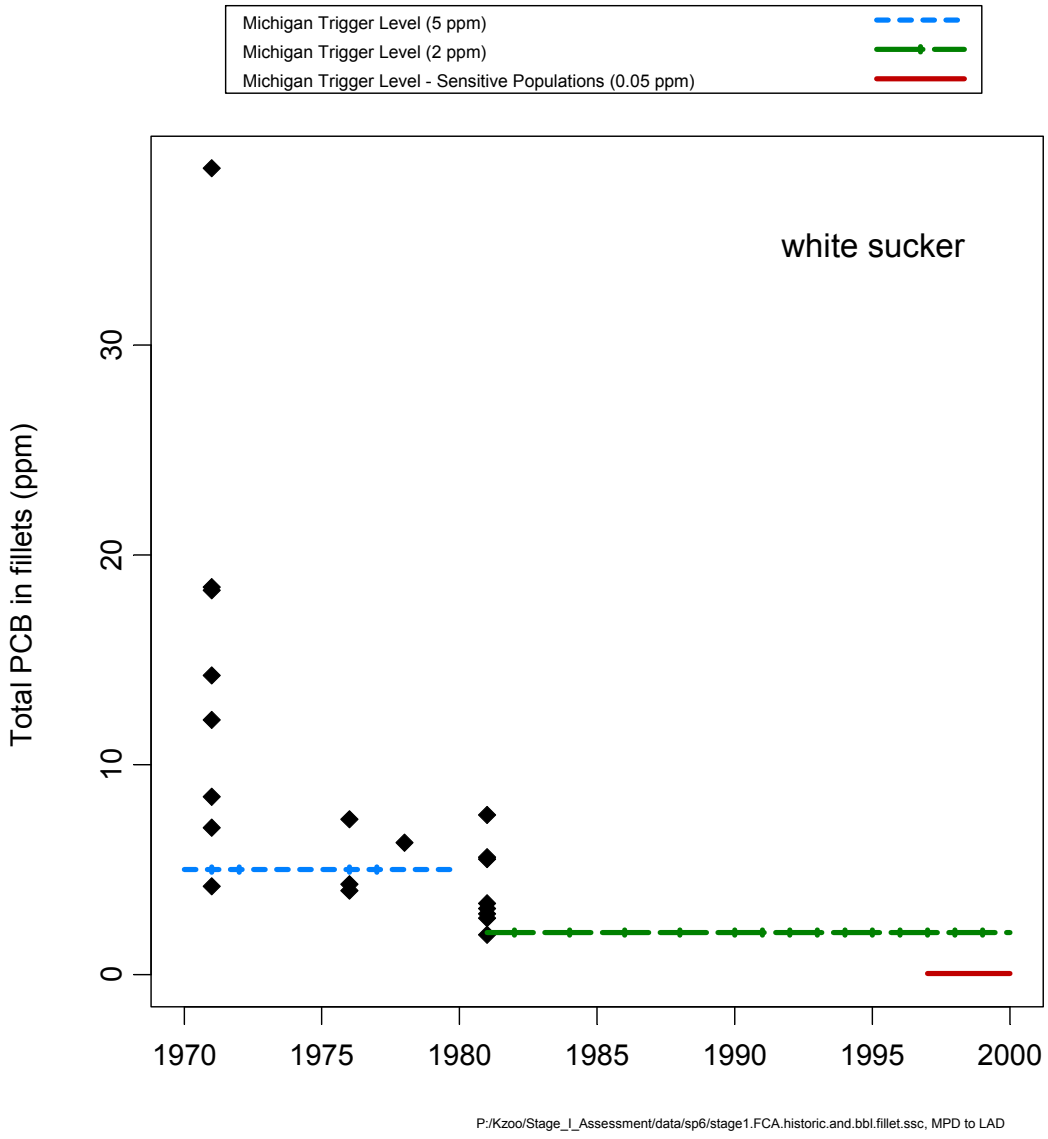

Figure 5.9. Total PCBs in fillets of white sucker collected between Morrow Dam and Lake Allegan Dam, 1971-2000.

Source: See Section 5.4.1.

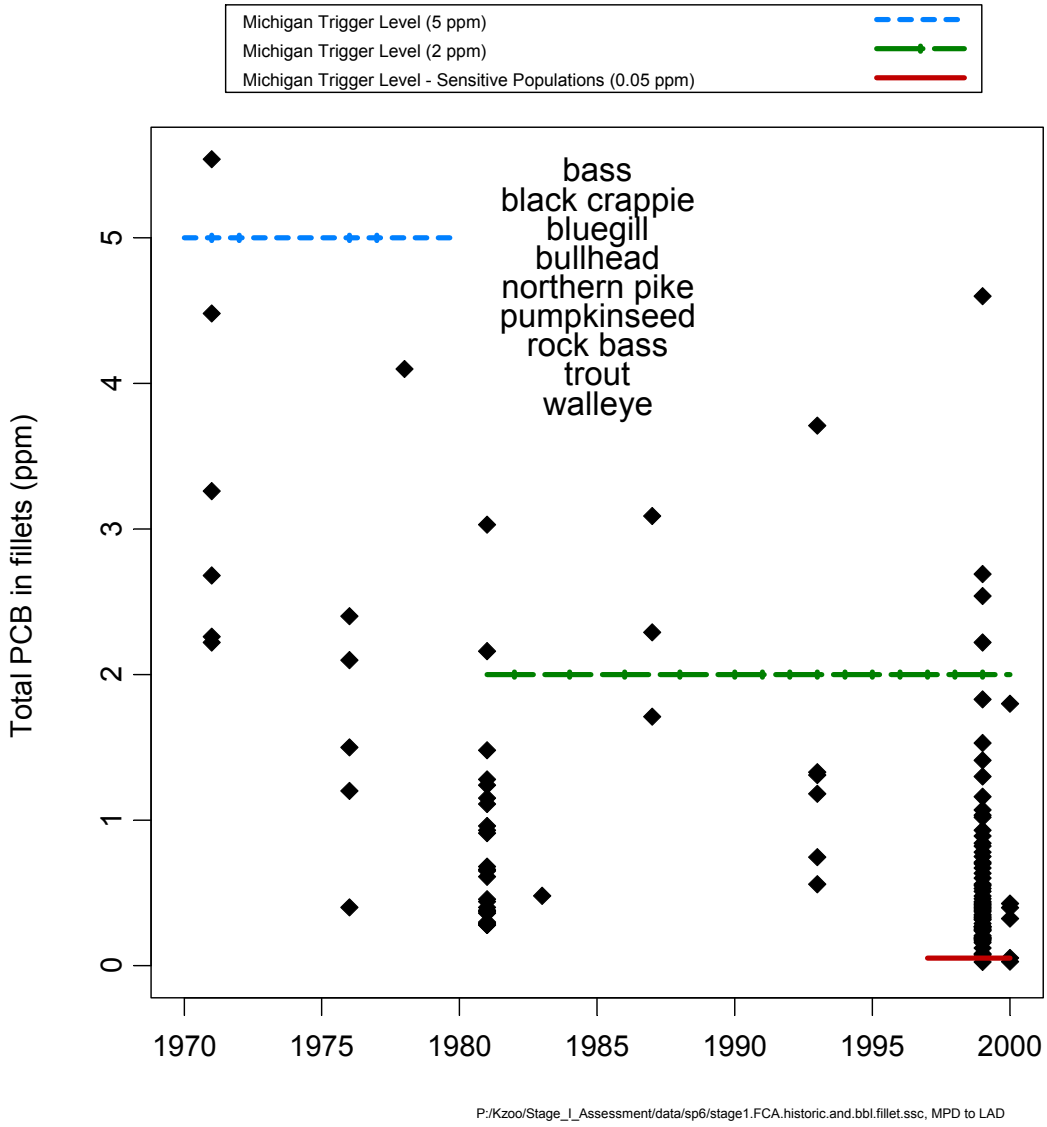

Figure 5.10. Total PCBs in fillets of other species under a general "all other species" advisory collected between Morrow Dam and Lake Allegan Dam, 1971-2000.

Source: See Section 5.4.1.

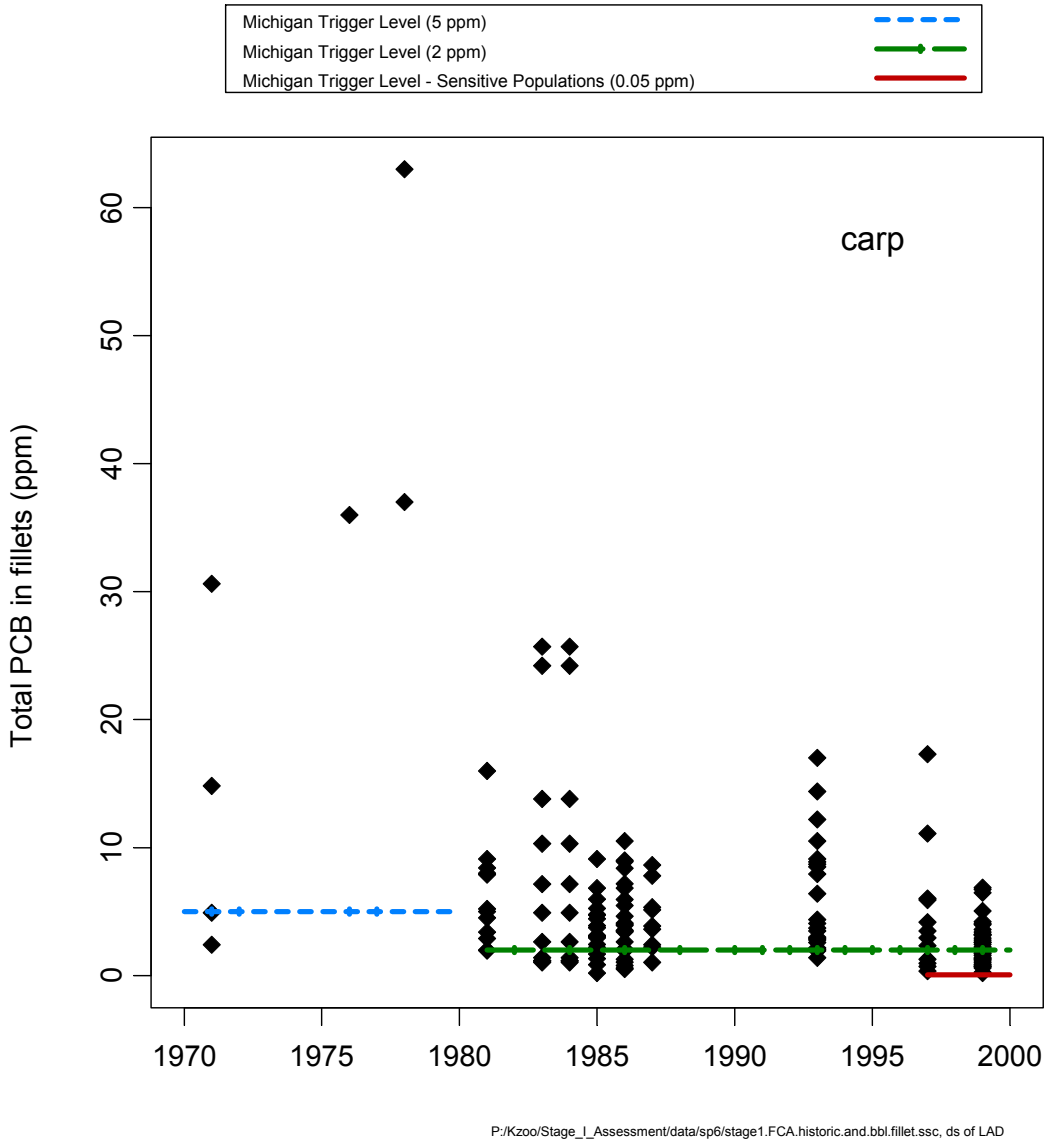

Figure 5.11. Total PCBs in fillets of carp collected downstream of Lake Allegan Dam, 1971-2000.

Source: See Section 5.4.1.

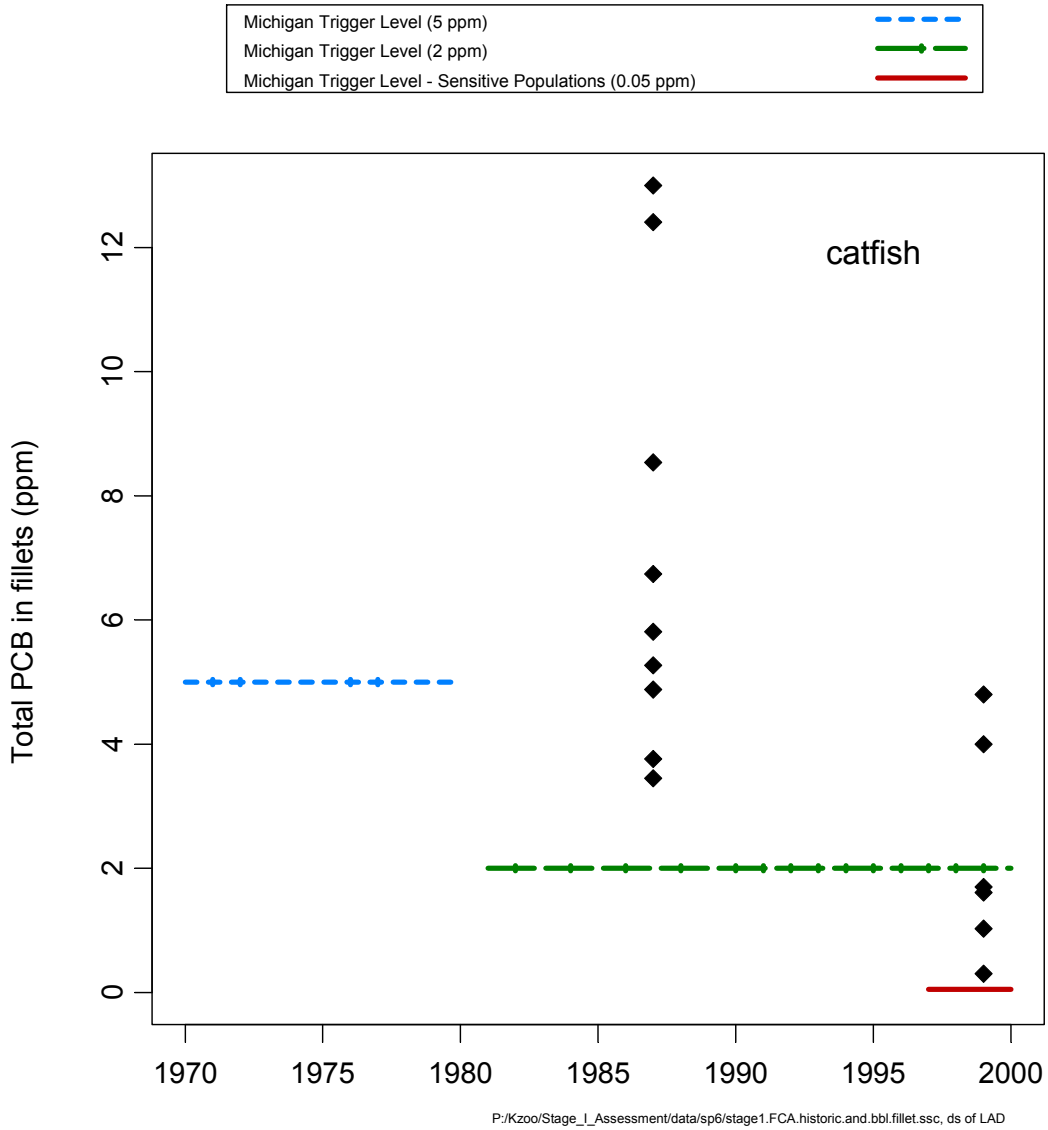

Figure 5.12. Total PCBs in fillets of catfish collected downstream of Lake Allegan Dam, 1971-2000.

Source: See Section 5.4.1.

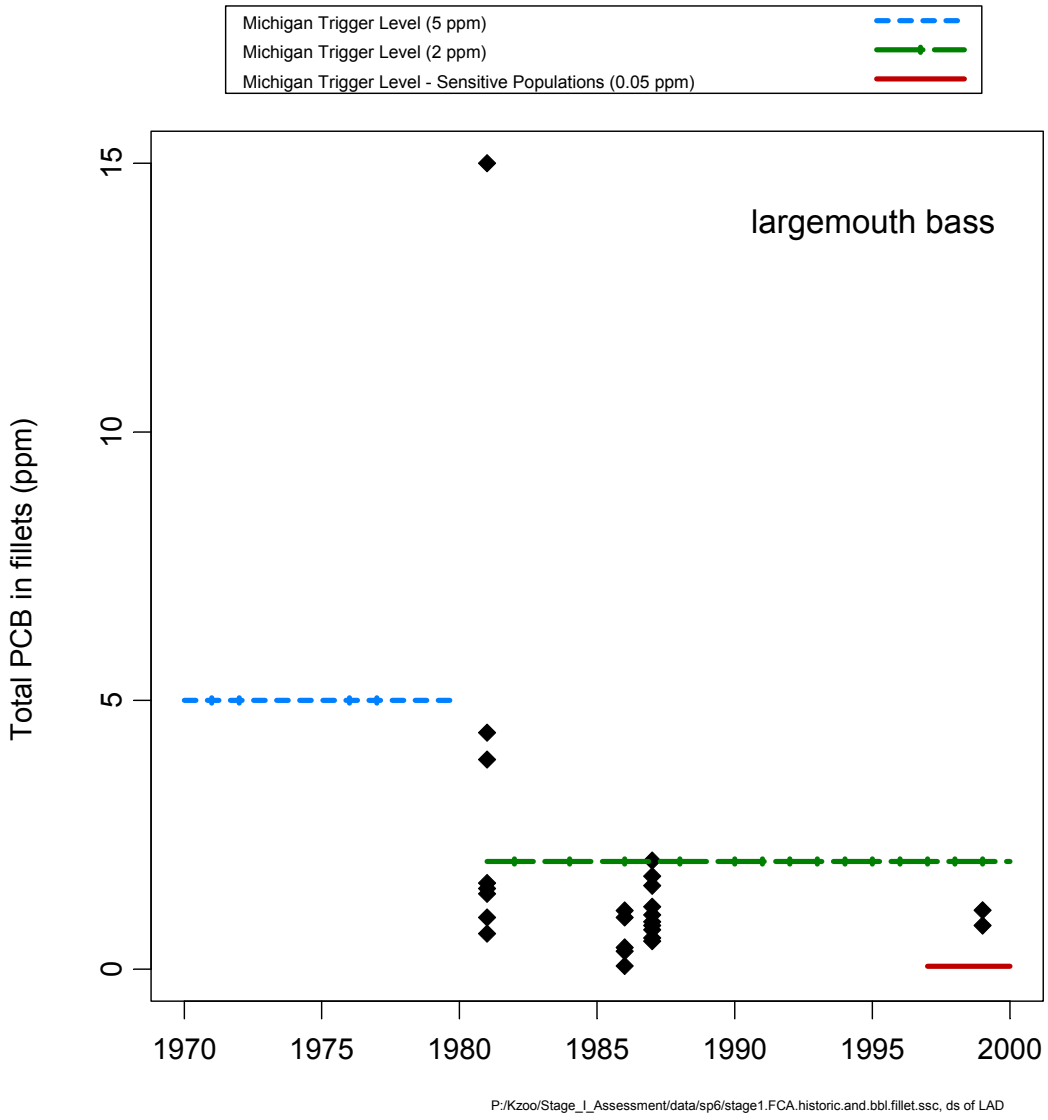

Figure 5.13. Total PCBs in fillets of largemouth bass collected downstream of Lake Allegan Dam, 1971-2000.

Source: See Section 5.4.1.

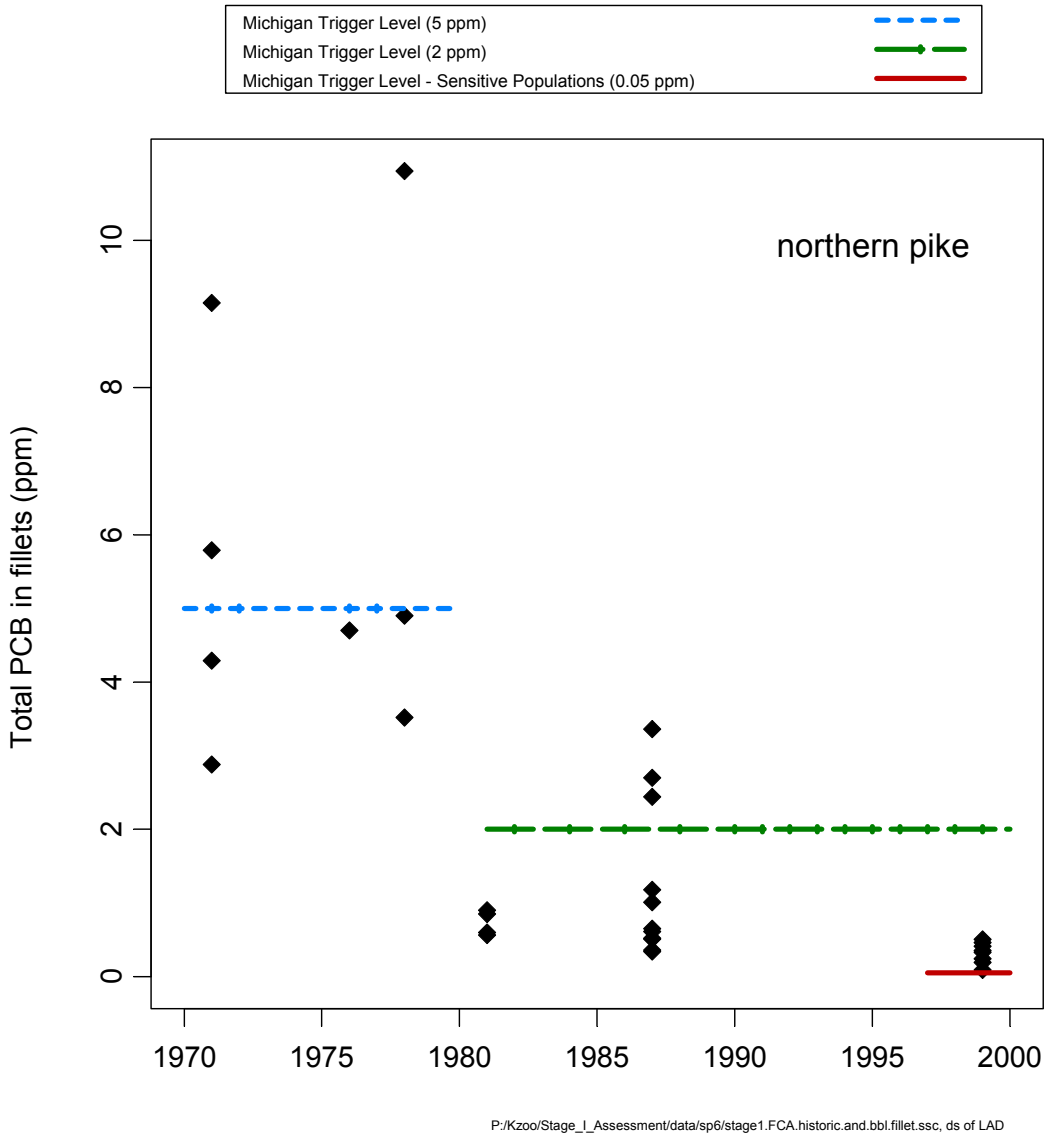

Figure 5.14. Total PCBs in fillets of northern pike collected downstream of Lake Allegan Dam, 1971-2000.

Source: See Section 5.4.1.

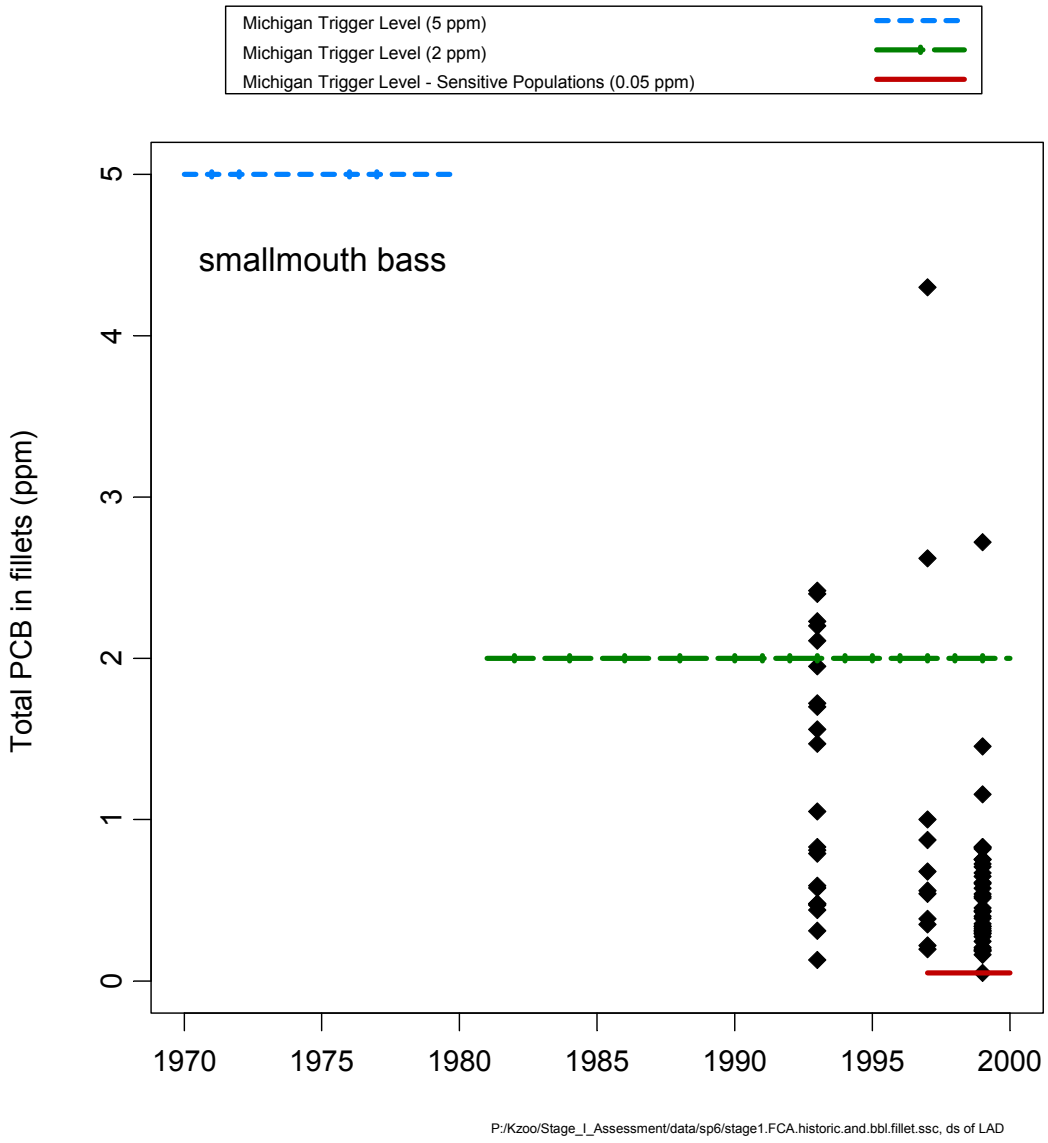

Figure 5.15. Total PCBs in fillets of smallmouth bass collected downstream of Lake Allegan Dam, 1971-2000.

Source: See Section 5.4.1.

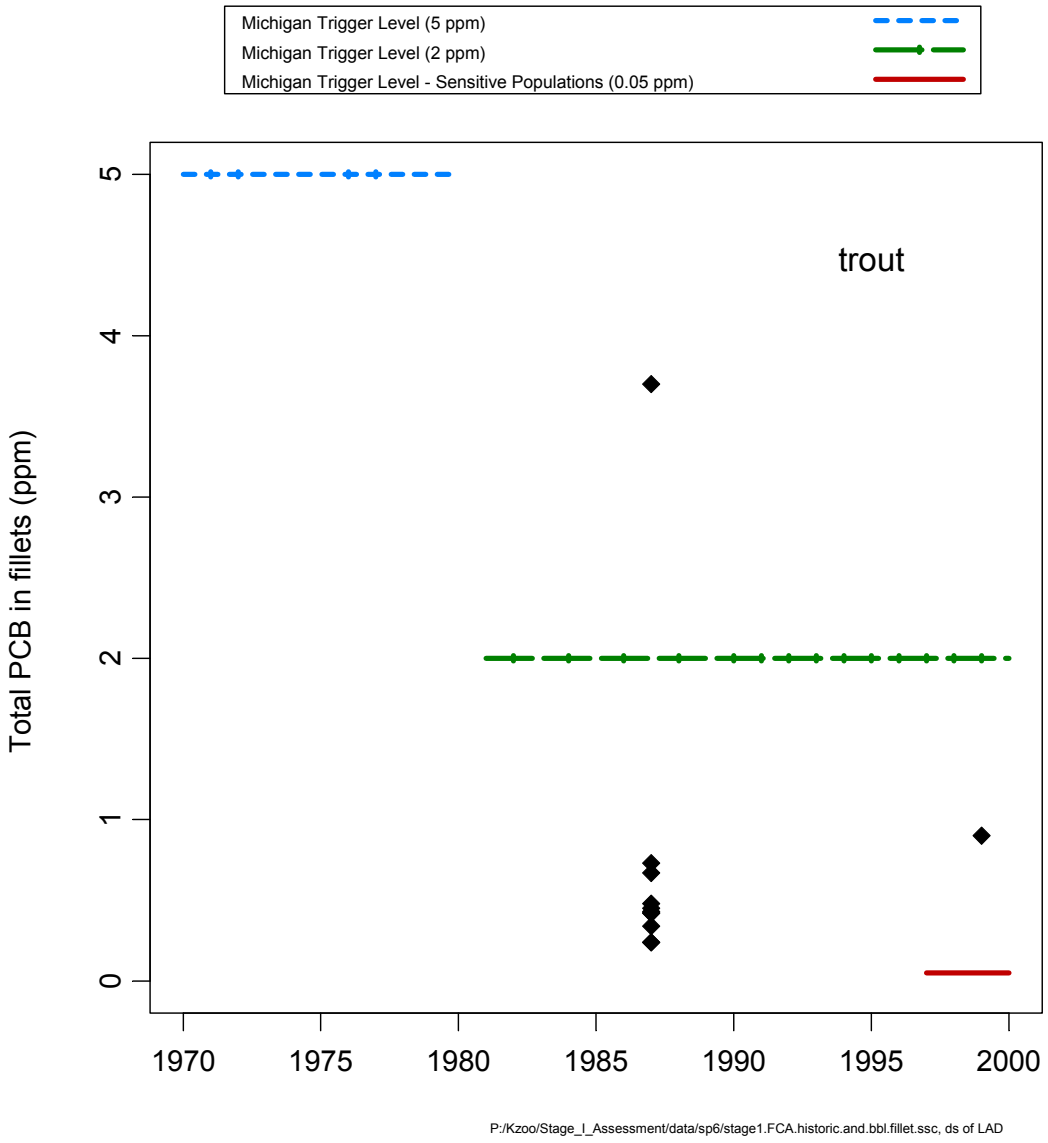

Figure 5.16. Total PCBs in fillets of trout collected downstream of Lake Allegan Dam, 1971-2000.

Source: See Section 5.4.1.

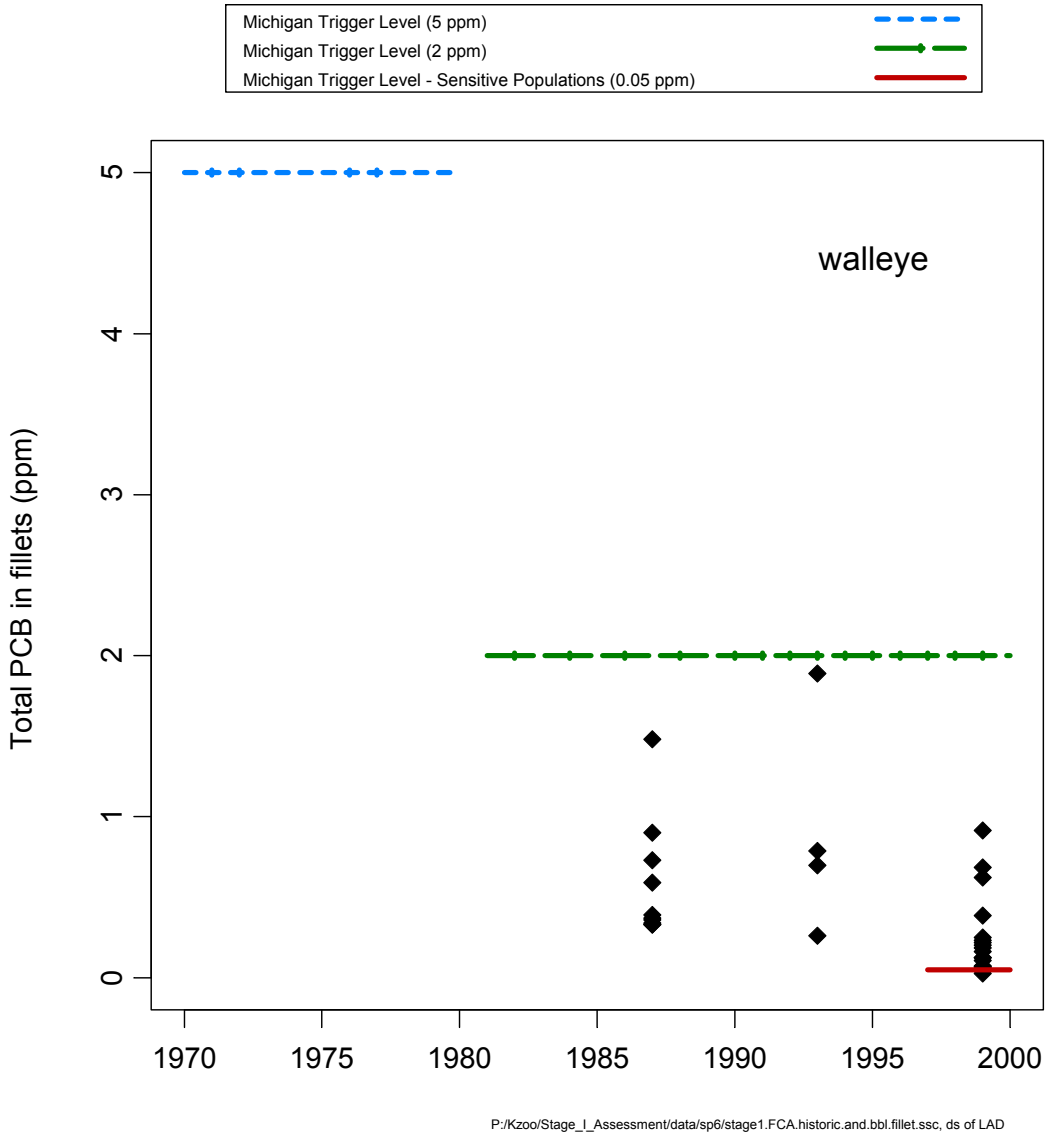

Figure 5.17. Total PCBs in fillets of walleye collected downstream of Lake Allegan Dam, 1971-2000.

Source: See Section 5.4.1.

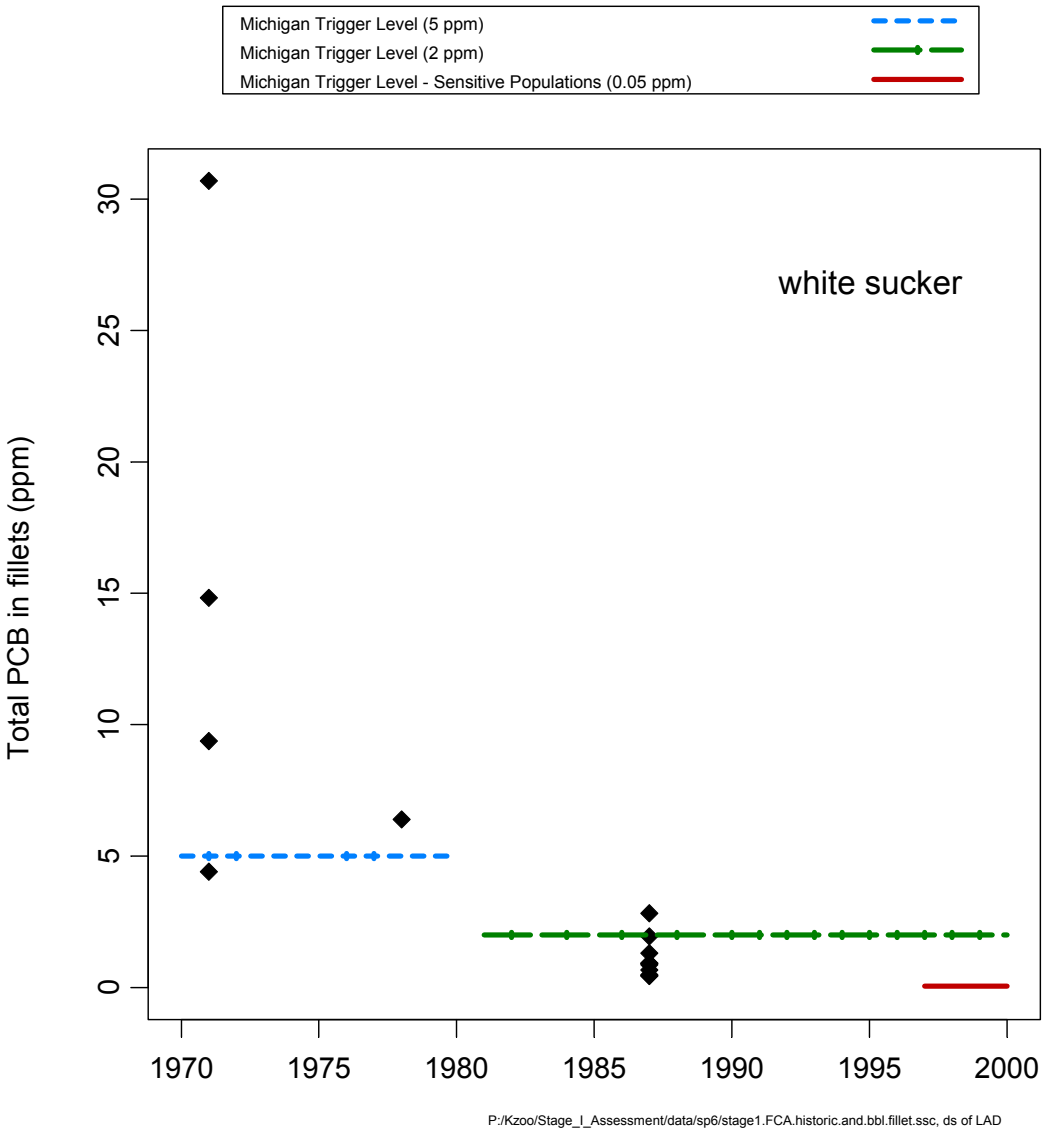

Figure 5.18. Total PCBs in fillets of white sucker collected downstream of Lake Allegan Dam, 1971-2000.

Source: See Section 5.4.1.

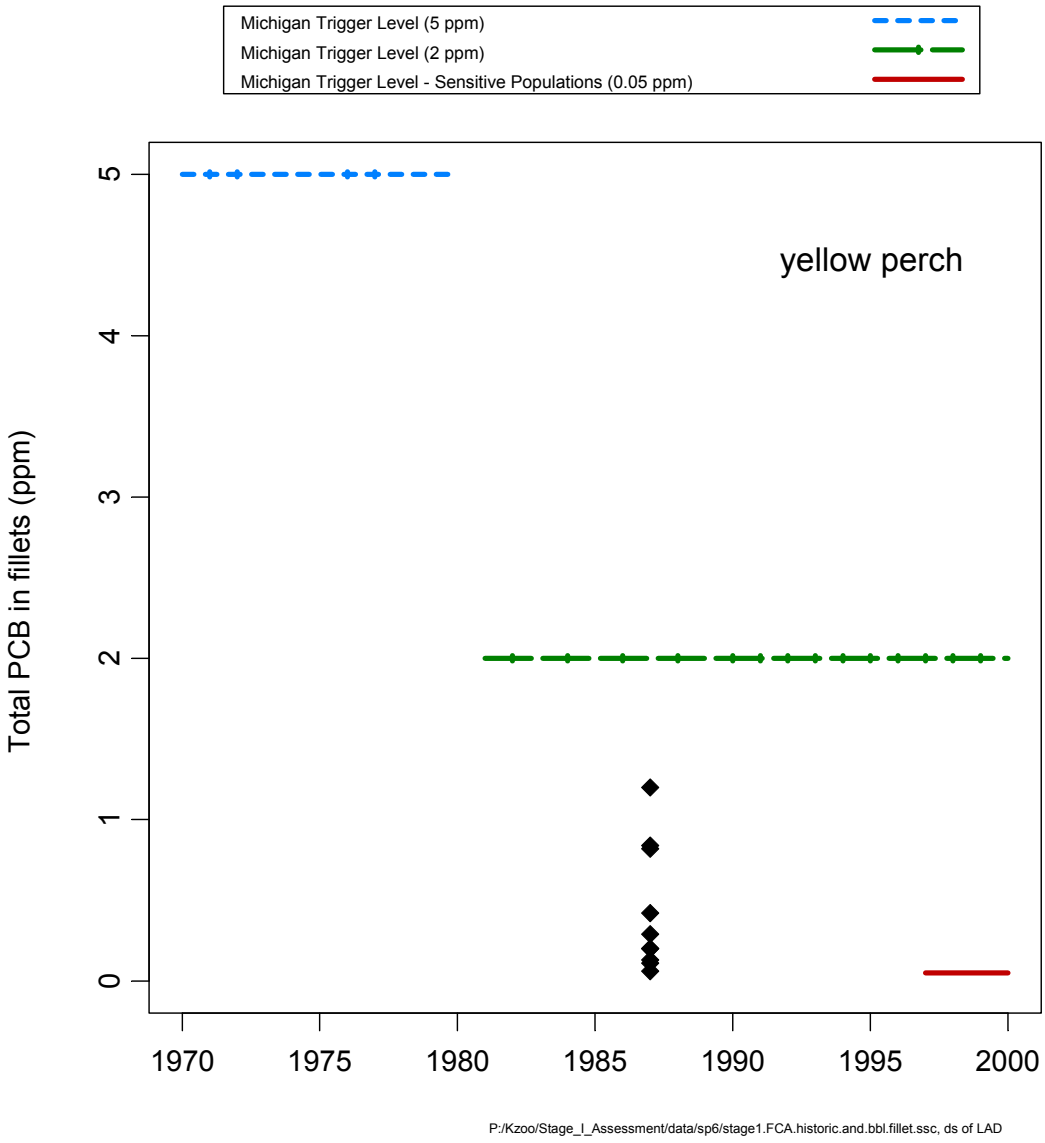

Figure 5.19. Total PCBs in fillets of yellow perch collected downstream of Lake Allegan Dam, 1971-2000.

Source: See Section 5.4.1.

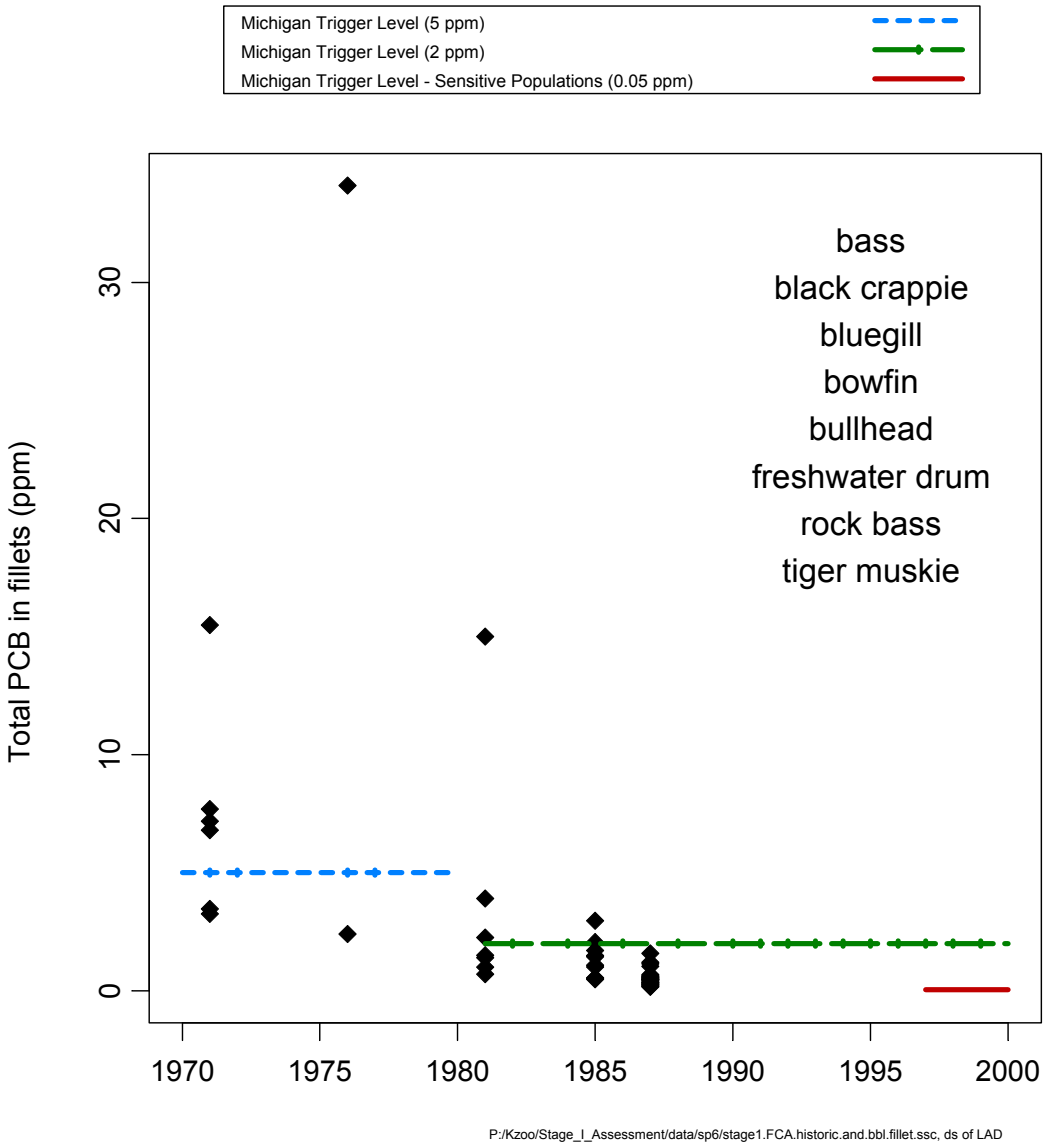

Figure 5.20. Total PCBs in fillets of other species under a general "all other species" advisory collected downstream of Lake Allegan Dam, 1971-2000.

Source: See Section 5.4.1.

walleye (Figure 5.17), and white sucker (Figure 5.18) exceeded trigger levels in place at the time of collection. In all of the samples from these species, only three walleye samples and one smallmouth bass sample collected in 1999 had PCB concentrations lower than the 0.05 ppm trigger level for sensitive populations. None of the yellow perch samples from 1987 exceeded the 2 ppm trigger level (Figure 5.19). Although the majority of samples from species that are under a general advisory in this reach (unknown species of bass, black crappie, bluegill, bowfin, bullhead, freshwater drum, rock bass, and tiger muskie) were below trigger levels, some samples did exceed them (Figure 5.20).

Overall, the tissue data indicate that Michigan's FCAs for the Kalamazoo River have a reasonable basis in the data. In all cases where data are available for species under a specific advisory in a given reach (see Tables 5.2 and 5.3), the total PCB concentration in fillets has exceeded trigger levels in some samples (Figures 5.3, 5.5-5.9, 5.11-5.18). Additionally, fillet samples from many species that fall under an "all other species" advisory exceeded the trigger levels at times (Figures 5.10 and 5.20). Samples collected from species that do not fall under any advisory were also found to exceed trigger levels (Figure 5.4). Ongoing monitoring conducted by MDEQ in 2001 and 2002 indicates that concentrations in fillets continue to exceed trigger levels (MDEQ, 2002, 2003).

5.5 Exceedences of the FDA Tolerance Level for PCBs

Fishery resources are injured if they contain concentrations of a hazardous substance sufficient to exceed action levels or tolerances established by the Food and Drug Administration (FDA) pursuant to the Food, Drug, and Cosmetic Act [43 C.F.R. § 11.62 (f)(1)(ii)]. This section compares measured PCB fillet concentrations with FDA tolerance levels.

5.5.1 Data sources

The data used to evaluate exceedences of the FDA tolerance level are the same used to evaluate exceedences of the Michigan FCA trigger levels and are described in Section 5.4.1.

5.5.2 Regulatory criteria and standards

FDA Tolerance levels are regulatory standards that are based on human health risk, while action levels are less formal administrative instructions that are more readily instituted and changed, and are generally replaced by a tolerance level (Boyer et al., 1991). The FDA proposed setting tolerance levels for PCBs in 1972 (Boyer et al., 1991), and established a temporary tolerance level of 5 ppm for PCBs in fish and shellfish in 1973 (38 Fed. Reg. 18096). At that time, the FDA stated that "the possibility of potential long-term hazards necessitates reduction of PCBs in

food as soon as possible." The advisories were considered "temporary" because "new data may justify a further downward revision of the tolerances" (42 Fed. Reg. 17493). The tolerance level was reduced to 2 ppm in 1984, based on further analysis of human health risks at different exposure levels (49 Fed. Reg. 21514). This reduction is codified at 21 C.F.R. § 109.30 (a)(7).

Therefore, PCB concentrations measured in edible portions of fish collected between 1973 and 1983 in the Kalamazoo River and Portage Creek are compared with the applicable FDA tolerance level of 5 ppm and concentrations in fish collected since 1984 are compared to the FDA tolerance level of 2 ppm.

5.5.3 Results

In most species collected between Battle Creek and Morrow Dam (upstream of PRP facilities), no or very few samples exceeded the FDA tolerance levels (Table 5.7). Carp fillets had PCB concentrations higher than these levels approximately 18% of the time. However, PCB concentrations in carp fillets have not exceeded the tolerance level since 1987. No samples from other species collected in this reach exceeded the tolerance level.

Samples of some species collected in the Kalamazoo River between Morrow Dam and Lake Allegan Dam and in Portage Creek exceeded the tolerance levels (Table 5.8). On average, 61% of carp fillets exceeded tolerance levels, and exceedences have persisted over time. Although fewer samples of other species have been collected, concentrations of PCBs in those fillets also exceeded the tolerance levels. Twenty-two percent of the fillet samples collected from channel catfish, 33% of largemouth bass, 23% of northern pike, 12% of smallmouth bass, 5% of walleye, and 42% of white sucker had PCB concentrations above the tolerance levels. Bass of unknown species, black crappie, bluegill, bullhead, pumpkinseed, rock bass, and trout had no samples with PCB concentrations exceeding the FDA tolerance levels in this reach.

As in the previous reach, many species sampled in the Kalamazoo River downstream of Lake Allegan Dam also exceeded FDA tolerance levels (Table 5.9). Carp and catfish had the highest concentrations and frequency of exceedence (68% and 73%, respectively). Fewer samples were collected of other species in this reach. However, 24% of bass of unknown species, 8% of largemouth bass, 15% of northern pike, 11% of smallmouth bass, 8% of trout, and 18% of white sucker fillets exceeded the tolerance levels. Of the species sampled, no black crappie, bluegill, bowfin, freshwater drum, rock bass, tiger muskie, walleye, or yellow perch fillets exceeded the tolerance levels.

Table 5.7. Summary of PCB tissue concentrations and frequency of exceedences of FDA tolerance levels for fish in the Kalamazoo River between Battle Creek and Morrow Dam

Species	Parameter[a]	1976	1981	1985	1986	1987	1993	1997	1999	2000
Bass	Number of samples	1	—	—	—	—	—	—	—	—
	Maximum PCB conc. (ppm)	0.1	—	—	—	—	—	—	—	—
	% exceeding tolerance level	0.0%	—	—	—	—	—	—	—	—
Carp	Number of samples	1	11	20	19	18	22	22	33	11
	Maximum PCB conc. (ppm)	2.1	8.1	8.9	12.7	5.8	1.9	0.7	1.0	0.4
	% exceeding tolerance level	0.0%	18.2%	75.0%	52.6%	5.6%	0.0%	0.0%	0.0%	0.0%
Largemouth bass	Number of samples	—	2	3	—	1	—	—	—	—
	Maximum PCB conc. (ppm)	—	0.2	2.0	—	0.02	—	—	—	—
	% exceeding tolerance level	—	0.0%	0.0%	—	0.0%	—	—	—	—
Northern pike	Number of samples	1	1	—	—	—	—	—	—	—
	Maximum PCB conc. (ppm)	3.7	0.1	—	—	—	—	—	—	—
	% exceeding tolerance level	0.0%	0.0%	—	—	—	—	—	—	—
Smallmouth bass	Number of samples	—	25	4	—	11	22	22	33	11
	Maximum PCB conc. (ppm)	—	1.8	1.4	—	1.3	0.7	0.3	1.1	0.03
	% exceeding tolerance level	—	0.0%	0.0%	—	0.0%	0.0%	0.0%	0.0%	0.0%
Walleye	Number of samples	—	—	—	—	—	3	—	—	—
	Maximum PCB conc. (ppm)	—	—	—	—	—	0.3	—	—	—
	% exceeding tolerance level	—	—	—	—	—	0.0%	—	—	—
White sucker	Number of samples	1	—	—	—	—	—	—	—	—
	Maximum PCB conc. (ppm)	2.0	—	—	—	—	—	—	—	—
	% exceeding tolerance level	0.0%	—	—	—	—	—	—	—	—

a. Percent exceeding tolerance level is based on a level of 5 ppm PCB before 1984 and 2 ppm PCB from 1984 on.

Table 5.8. Summary of PCB tissue concentrations and frequency of exceedences of FDA tolerance levels for fish in the Kalamazoo River between Morrow Dam and Lake Allegan Dam, and in Portage Creek

Species	Parameter[a]	1976	1978	1981	1983	1985	1986	1987	1993	1997	1999	2000
Bass	Number of samples	4	—	—	—	—	—	—	—	—	—	—
	Maximum PCB conc. (ppm)	2.4	—	—	—	—	—	—	—	—	—	—
	% exceeding tolerance level	0.0%	—	—	—	—	—	—	—	—	—	—
Black crappie	Number of samples	—	—	3	—	—	—	—	—	—	1	1
	Maximum PCB conc. (ppm)	—	—	3.0	—	—	—	—	—	—	1.2	0.4
	% exceeding tolerance level	—	—	0.0%	—	—	—	—	—	—	0.0%	0.0%
Bluegill (sunfish)	Number of samples	—	—	9	1	—	—	—	—	—	30	—
	Maximum PCB conc. (ppm)	—	—	1.3	0.5	—	—	—	—	—	0.8	—
	% exceeding tolerance level	—	—	0.0%	0.0%	—	—	—	—	—	0.0%	—
Bullhead (inc. black bullhead and yellow bullhead)	Number of samples	—	—	6	—	—	—	—	—	—	—	—
	Maximum PCB conc. (ppm)	—	—	0.7	—	—	—	—	—	—	—	—
	% exceeding tolerance level	—	—	0.0%	—	—	—	—	—	—	—	—
Carp	Number of samples	6	1	56	25	69	143	29	88	22	110	33
	Maximum PCB conc. (ppm)	13.8	51.3	47.0	15.9	14.0	27.4	17.1	17.2	17.3	21.7	10.3
	% exceeding tolerance level	100%	100%	25.0%	28.0%	87.0%	70.6%	62.1%	70.5%	31.8%	60.9%	27.3%
Channel catfish	Number of samples	—	—	1	—	—	—	—	—	—	17	—
	Maximum PCB conc. (ppm)	—	—	1.6	—	—	—	—	—	—	5.4	—
	% exceeding tolerance level	—	—	0.0%	—	—	—	—	—	—	23.5%	—
Largemouth bass	Number of samples	—	—	6	1	7	—	—	—	—	—	1
	Maximum PCB conc. (ppm)	—	—	2.1	0.4	6.5	—	—	—	—	—	0.3
	% exceeding tolerance level	—	—	0.0%	0.0%	71.4%	—	—	—	—	—	0.0%

Table 5.8. Summary of PCB tissue concentrations and frequency of exceedences of FDA tolerance levels for fish in the Kalamazoo River between Morrow Dam and Lake Allegan Dam, and in Portage Creek (cont.)

Species	Parameter[a]	1976	1978	1981	1983	1985	1986	1987	1993	1997	1999	2000
Northern pike	Number of samples	1	1	5	—	—	—	3	—	—	15	1
	Maximum PCB conc. (ppm)	2.1	4.1	1.0	—	—	—	3.1	—	—	4.6	0.4
	% exceeding tolerance level	0.0%	0.0%	0.0%	—	—	—	66.7%	—	—	26.7%	0.0%
Pumpkinseed	Number of samples	—	—	1	—	—	—	—	—	—	14	—
	Maximum PCB conc. (ppm)	—	—	2.2	—	—	—	—	—	—	0.6	—
	% exceeding tolerance level	—	—	0.0%	—	—	—	—	—	—	0.0%	—
Rock bass	Number of samples	—	—	1	—	—	—	—	—	—	—	1
	Maximum PCB conc. (ppm)	—	—	1.5	—	—	—	—	—	—	—	0.03
	% exceeding tolerance level	—	—	0.0%	—	—	—	—	—	—	—	0.0%
Smallmouth bass	Number of samples	—	—	10	—	6	—	10	77	22	121	32
	Maximum PCB conc. (ppm)	—	—	2.2	—	3.3	—	5.1	5.8	1.6	5.1	2.3
	% exceeding tolerance level	—	—	0.0%	—	50%	—	70%	24.7%	0.0%	2.5%	3.1%
Trout	Number of samples	—	—	—	—	—	—	—	—	—	—	1
	Maximum PCB conc. (ppm)	—	—	—	—	—	—	—	—	—	—	0.05
	% exceeding tolerance level	—	—	—	—	—	—	—	—	—	—	0.0%
Walleye	Number of samples	—	—	—	—	—	—	—	6	—	13	2
	Maximum PCB conc. (ppm)	—	—	—	—	—	—	—	3.7	—	1.5	1.8
	% exceeding tolerance level	—	—	—	—	—	—	—	16.7%	—	0.0%	0.0%
White sucker	Number of samples	3	1	8	—	—	—	—	—	—	—	—
	Maximum PCB conc. (ppm)	7.4	6.3	7.6	—	—	—	—	—	—	—	—
	% exceeding tolerance level	33.3%	100%	37.5%	—	—	—	—	—	—	—	—

a. Percent exceeding tolerance level is based on a level of 5 ppm PCB before 1984 and 2 ppm PCB from 1984 on.

Table 5.9. Summary of PCB tissue concentrations and frequency of exceedences of FDA tolerance levels for fish in the Kalamazoo River downstream of Lake Allegan Dam

Species	Parameter[a]	1976	1978	1981	1983	1984	1985	1986	1987	1993	1997	1999
Bass	Number of samples	1	—	6	—	—	10	—	—	—	—	—
	Maximum PCB conc. (ppm)	34.1	—	15.0	—	—	3.0	—	—	—	—	—
	% exceeding tolerance level	100%	—	16.7%	—	—	20.0%	—	—	—	—	—
Black crappie	Number of samples	—	—	—	—	—	—	—	10	—	—	—
	Maximum PCB conc. (ppm)	—	—	—	—	—	—	—	1.6	—	—	—
	% exceeding tolerance level	—	—	—	—	—	—	—	0.0%	—	—	—
Bluegill (sunfish)	Number of samples	—	—	—	—	—	—	—	10	—	—	—
	Maximum PCB conc. (ppm)	—	—	—	—	—	—	—	0.7	—	—	—
	% exceeding tolerance level	—	—	—	—	—	—	—	0.0%	—	—	—
Bowfin	Number of samples	—	—	2	—	—	—	—	—	—	—	—
	Maximum PCB conc. (ppm)	—	—	2.3	—	—	—	—	—	—	—	—
	% exceeding tolerance level	—	—	0.0%	—	—	—	—	—	—	—	—
Carp	Number of samples	1	2	18	11	11	20	24	9	22	12	43
	Maximum PCB conc. (ppm)	36.0	63.0	16.0	25.7	25.7	9.1	10.5	8.6	17.0	17.3	6.9
	% exceeding tolerance level	100%	100%	55.6%	45.5%	63.6	80.0%	75.0%	88.9%	90.9%	66.7%	51.2%
Channel catfish (and flat catfish)	Number of samples	—	—	—	—	—	—	—	9	—	—	6
	Maximum PCB conc. (ppm)	—	—	—	—	—	—	—	13.0	—	—	4.8
	% exceeding tolerance level	—	—	—	—	—	—	—	100%	—	—	33.3%
Freshwater drum	Number of samples	—	—	—	—	—	—	—	1	—	—	—
	Maximum PCB conc. (ppm)	—	—	—	—	—	—	—	1.2	—	—	—
	% exceeding tolerance level	—	—	—	—	—	—	—	0.0%	—	—	—

Table 5.9. Summary of PCB tissue concentrations and frequency of exceedences of FDA tolerance levels for fish in the Kalamazoo River downstream of Lake Allegan Dam (cont.)

Species	Parameter[a]	1976	1978	1981	1983	1984	1985	1986	1987	1993	1997	1999
Largemouth bass	Number of samples	—	—	8	—	—	—	5	10	—	—	2
	Maximum PCB conc. (ppm)	—	—	15.0	—	—	—	1.1	2.0	—	—	1.1
	% exceeding tolerance level	—	—	12.5%	—	—	—	0.0%	10.0%	—	—	0.0%
Northern pike	Number of samples	1	3	4	—	—	—	—	11	—	—	8
	Maximum PCB conc. (ppm)	4.7	10.9	0.8	—	—	—	—	3.4	—	—	0.5
	% exceeding tolerance level	0.0%	33.3%	0.0%	—	—	—	—	27.3%	—	—	0.0%
Rock bass	Number of samples	—	—	—	—	—	—	—	10	—	—	—
	Maximum PCB conc. (ppm)	—	—	—	—	—	—	—	0.5	—	—	—
	% exceeding tolerance level	—	—	—	—	—	—	—	0.0%	—	—	—
Smallmouth bass	Number of samples	—	—	—	—	—	—	—	—	22	11	40
	Maximum PCB conc. (ppm)	—	—	—	—	—	—	—	—	2.4	4.3	2.7
	% exceeding tolerance level	—	—	—	—	—	—	—	—	22.7%	18.2%	2.5%
Tiger muskie	Number of samples	1	—	—	—	—	—	—	—	—	—	—
	Maximum PCB conc. (ppm)	2.4	—	—	—	—	—	—	—	—	—	—
	% exceeding tolerance level	0.0%	—	—	—	—	—	—	—	—	—	—
Trout (brown and rainbow)	Number of samples	—	—	—	—	—	—	—	11	—	—	1
	Maximum PCB conc. (ppm)	—	—	—	—	—	—	—	3.7	—	—	0.9
	% exceeding tolerance level	—	—	—	—	—	—	—	9.1%	—	—	0.0%
Walleye	Number of samples	—	—	—	—	—	—	—	10	4	—	19
	Maximum PCB conc. (ppm)	—	—	—	—	—	—	—	1.5	1.9	—	0.9
	% exceeding tolerance level	—	—	—	—	—	—	—	0.0%	0.0%	—	0.0%

Table 5.9. Summary of PCB tissue concentrations and frequency of exceedences of FDA tolerance levels for fish in the Kalamazoo River downstream of Lake Allegan Dam (cont.)

Species	Parameter[a]	1976	1978	1981	1983	1984	1985	1986	1987	1993	1997	1999
White sucker	Number of samples	—	1	—	—	—	—	—	10	—	—	—
	Maximum PCB conc. (ppm)	—	6.4	—	—	—	—	—	2.8	—	—	—
	% exceeding tolerance level	—	100%	—	—	—	—	—	10.0%	—	—	—
Yellow perch	Number of samples	—	—	—	—	—	—	—	10	—	—	—
	Maximum PCB conc. (ppm)	—	—	—	—	—	—	—	1.2	—	—	—
	% exceeding tolerance level	—	—	—	—	—	—	—	0.0%	—	—	—

a. Percent exceeding tolerance level is based on a level of 5 ppm PCB before 1984 and 2 ppm PCB from 1984 on.

Review of the maximum PCB concentrations and the percentage of fillet PCB concentrations that exceed the FDA tolerance level indicates that the FDA tolerance has been and continues to be exceeded in multiple species in the Kalamazoo River between Morrow Dam and Lake Michigan, and in Portage Creek. Exceedences in these reaches have occurred since the establishment of the tolerance level in 1973 and have persisted through at least 2000.

5.6 Conclusions

Fish consumption advisories due to PCB contamination have been issued for many species in Portage Creek and the Kalamazoo River from Morrow Dam to Lake Michigan. Based on the extent and magnitude of PCB contamination in surface water and sediments throughout the KRE, the Trustees expect that consumption advisories will continue into the future. Although there is a consumption advisory for carp upstream of PRP facilities, advisories downstream of PRP facilities are more severe and apply to more species. The Trustees conclude that fish in Portage Creek and the Kalamazoo River have been injured according to the definition in 43 C.F.R. § 11.62(f)(1)(iii).

PCB concentrations in fish tissue have also exceeded tolerance levels established by the FDA under the Food, Drug and Cosmetic Act. A high percentage of samples exceeded the FDA tolerance levels in Portage Creek and the Kalamazoo River from Morrow Dam to Lake Michigan. Concentrations have exceeded these tolerance levels since the early 1970s and exceedences continue through 2000, the most recent year for which data are available. Based on the extent and magnitude of PCB contamination in surface water and sediments throughout the KRE, the Trustees expect that exceedences will continue into the future. The Trustees conclude that fish in Portage Creek and the Kalamazoo River have been injured according to the definition in 43 C.F.R. § 11.62(f)(1)(ii).